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CLIMATE MAKES THE MAN

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by

CLARENCE A. MILLS, M.D., Ph.D.
Professor of Experimental Medicine
University of Cincinnati

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PART I

CHAPTER I

SUN WORSHIPPERS

TO-DAY'S WORLD TURMOIL and confusion have rudely awakened man from his cherished dream that he alone is the master of his own destiny. Even the most egotistic and confident person now feels uncertain of his sacred powers as he surveys a universe in which war and social revolution are striking at the very foundations of the only civilization he has known. Altruism seems suddenly to have given way to the rule of might, with humanity slipping back toward another Dark Age.

People everywhere have begun to suspect that mighty external forces are at work—forces against which their greatest efforts will prove small and futile. This feeling of futility in the face of a darkening future has awakened in the world's thinkers a desire to know more about these outside factors—what they are and how they work. Fortunately science has accumulated a considerable mass of evidence regarding the surprising and powerful effects exerted upon human beings by two of them: climate, the long-term average of atmospheric conditions, and weather, the short-cycle changes which make one day or hour different from the next. These findings are helping to put man in his proper place within the cosmic scheme of things, for the sun and planets exert an indirect but well-proved effect on all life through their control of earth temperatures and weather.

The awareness of a connection between the solar system and human welfare is older by far than recorded history. When the first human beings roamed a strange, hostile world some 500,000 years ago, they spent long nights huddled together in caves to escape the unknown terrors of darkness. They looked forward to the morning, for the first stages of man's battle to master his environment took place in broad daylight. It was only natural for our primeval ancestors to regard the sun with awe and gratitude, for it brought them light and warmth. Ages and civilizations passed, but this great feeling of dependence did not.

The Spaniards found this feeling in Peru during the sixteenth century when they set out to conquer a territory rich in gold. High in the lofty Andes little bands of Incas paused in reverence to face the rising sun and to receive its blessing before continuing their journey to Cuzco. Everywhere throughout the far-flung Incan empire other groups were bowing in similar adoration before the Giver of Life, for sun worship was the state religion of those people. They built massive and beautiful temples to provide the sun with the dignity and place of first importance it held in their lives. The moon and planets were also worshipped, but as deities far inferior to the all-powerful sun.

Reverence for the sun and its satellites was carried to great extremes in the earliest civilizations. All phases of life were closely regulated according to the positions of the planets and other heavenly bodies. People believed that outside forces exerted potent and direct influences over human affairs, and the astrologer's advice was always in demand. When men later discarded such primitive beliefs, they ignored the intuitive rightness of the feeling that humanity was not entirely its own lord and master. Humility was replaced by a laboratory-gained egotism as scientists obtained ever increasing control over their physical environment.

This over-confidence grew rapidly during the nineteenth century while researchers were piling discovery upon discovery. New inventions enabled us to harness electricity and perfect the telegraph, telephone, incandescent lamp, radio, and power transmission. Equally striking advances were made in the knowledge of the human body, its inner workings, its diseases, and the means of keeping it healthy. But the egotism which came with these and other material accomplishments began slipping in the last war; and to-day, when the notion that humanity controls its own fate has fallen into even greater disrepute, the same science which produced over-confidence in man is beginning to teach him a new humility.

Studies during the past few years have revealed that climatic factors in life play a startling and dominating role in all we do. Man as an energy machine thinks and acts only because of the burning of food in his tissues; but the speed of this burning—and the intensity of his living—depends largely upon outside temperatures and how easily he can get rid of his waste heat. Just why this is so will be considered in detail on later pages;it need only be said here that the climatic influences are real and clear-cut. They affect man's rate of growth, speed of development, resistance to infection, fertility of mind and body, and the amount of energy available for thought or action. The heat of the tropics lulls people into a passive complacency and saps their vitality; residents of colder climates are driven onward into restless activity, since natural conditions permit their tissue fires to burn more brightly.

Climate affects man's sicknesses as well as his health. In his vegetative tropical existence he is much more susceptible to infectious diseases, while in temperate coolness the stress of a more energetic life causes frequent breakdown in his body machinery and raises heart failure to a leading position among the causes of death. People seldom wear out in warm climates; in cooler regions breakdown diseases are now providing medical men with their keenest worries. The matter is an exceedingly important one for individual and public health. It richly deserves the close attention finally being accorded it.

People of the tropics can be raised out of their sluggish state into a higher vitality and more active life only when faster food burning can be maintained in their body tissues. In temperate coolness, on the other hand, ways must be found for reducing the stress of life and conserving the body machinery if we are to halt the rising rate of breakdown which now threatens civilization's advance. Too many of society's most progressive and valuable individuals are now succumbing just as they reach their most creative period.

Weather changes affect man also, but somewhat differently from climate. In many regions of the earth he has almost no weather problem to face; sudden variations in temperature and pressure seldom occur because cyclonic storms are lacking—only the climatic and seasonal influences are left. Violent and frequent storms bring to other regions major weather problems, with sudden atmospheric changes which rack body and mind. In the earth's most active storm belts this turbulence becomes a very important factor of existence, adding spice to life but at the same time interfering with body functions and bringing on many serious ailments. Such influences have been studied less than those of climate and cannot be discussed in as much detail. It should be kept in mind, however, that the two work together upon man in many regions. In between weather and climate come the seasons. They too are potent health factors—absent, of course, in the tropics.

The picture of these forces acting upon man is a fascinating one, still blurred in places, but with its main outlines clear-cut and definite. The sun does far more than merely provide daylight and the special forms of radiant energy needed by all growing things. Through its influence over world weather and climatic characteristics it dominates many other phases of human activity. Since the planets seem to be at the basis of changes in the sun's influence, we now begin to see man in his true relation to the solar system. He is not the independent master of his own life as he so fondly believed a few decades ago, but instead is pushed hither and yon by larger outside forces. He could learn a great deal from primitive sun-worshippers, for he is still a veritable pawn of the universe.

CHAPTER 2

HELPERS IN THE LABORATORY

"WHAT REAL EVIDENCE HAVE WE that climate influences mankind?" This will be the first question asked by many readers as they begin perusal of these pages. People have always bristled at the suggestion that they are not lords of creation. The idea that weather and climate are to be credited with the ambitious activity of temperate-zone citizens, or for the slower-paced life of tropical dwellers, strikes at one of the firmest beliefs of human beings: that their actions are independent of great and uncontrollable outside forces. It may not be flattering for the doubting Thomas to learn that rats and other animals have helped furnish much important evidence for humanity's dependence upon the elements; but such is the case, and these helpers in the laboratory can never receive too much praise for their contributions.

Few persons outside scientific circles appreciate how much humanity owes to the laboratory animals. Rats, white mice, rabbits, and the famed guinea-pigs are almost as fully domesticated as horses, cattle, and hogs. Instead of doing our work or supplying us with much-needed food, these docile creatures give valuable information about how our bodies work and how to keep them healthy. Only with their help could medical science make many of the wonderful discoveries that have brought the great health improvements of the past half-century.

When you think of a rat, is it with almost the same aversion you feel for snakes? Such dislike may be justified in the case of wild rats, but I assure you it is not with the Wistar white rat. He is an intelligent, good-natured fellow, scrupulously clean in person and most reliable in his responses. His name was taken from the Wistar Institute in Philadelphia, where careful breeding through hundreds of generations weeded out abnormal and unwanted traits. These animals are now highly standardized and much favoured among scientists, responding to a given diet or special vitamin with almost the regularity of pure chemical reactions in its test tubes. The results obtained in one laboratory can be duplicated readily by far distant investigators under similar conditions.

Two such rats, Ivan (not the terrible) and Hilda, his mate, were adopted into the exclusive circles of our laboratory rat colony early in childhood. They were likable and appealing, with sparkling eyes and glossy fur, as they came to us just after having been weaned. New hands bothered them somewhat for the first few days, but soon all strangeness disappeared. When they became accustomed to the new surroundings a delightful confidence and intimacy was established which has persisted to adult life. Curious as it may appear from the human angle, Ivan seems to enjoy handling and attention more than Hilda. He is less wrapped up in himself, more easily influenced, worrying little when his treacherous foster parents keep from him one essential food element after another. Even if he does lose vigour in the experimental "tropics" of a hot room, it is without ill-will and with a most appealing trust in his keepers. Restoring him to full health and vitality after a period of decline brings to us almost as much pleasure as the recovery from serious illness of our own human children.

Among our numerous white rats, Ivan and Hilda have been willing co-workers for years as we have studied the various phases of climatic influences. They have spent weeks shivering in the cold without complaint and endured tropical heat with calm complacency. When temperatures were too high and they began to develop fever, they wet their fur on the nozzle of the water bottle and lay relaxed to keep their own heat production down to a minimum. They have been finicky about eating their food in the heat and enjoyed gluttonous appetites in the cold. They have provided much valuable information on climatic dominance over basic body functions and vitality. Climatic effects only suggested by human statistics have been made quite clear and definite through their help. They well deserve a Congressional Medal for services to the common good, but it matters not to them that no politician has yet attempted to champion their cause.

We often become quite attached to these willing and friendly helpers during months of close association. It is like watching an adopted child grow from babyhood through the vicissitudes of life, for we usually work with the rats from weaning time to adult life. Some of them are like shy and retiring children, but the majority are untroubled extroverts who love being handled. It saddens us to watch these little friends lose their appetites and fail in health as we omit from their diet some necessary element or otherwise vary experimental conditions. But afterwards comes miraculous recovery as the missing substance is restored. Overnight the sick are made well again when we know just what to do for them.

Rats are particularly valuable in studies of climate because their basic life functions very much resemble those of human beings. To grow, to reproduce, to digest food, to run and climb, and to do the hundred and one other things which fill the day for the modern rat—all these require energy, whose sole source is the burning of food in the body cells. But rats are no more efficient than people in their ability to use combustion energy. Like other warm-blooded animals, they must eliminate three or four units of heat from their bodies for every single unit actually used as energy to keep their life process going. In rats and human beings elimination of this waste heat goes on best in cool, temperate-zone climates. Tropical warmth slows the rate of heat loss, while Arctic surroundings permit heat to escape too rapidly for maximal efficiency. What these facts mean in the physiology of daily living has been shown largely by studies on laboratory animals.

In a fairly cool, natural environment, Ivan and Hilda eliminated their waste heat at a normal and efficient pace. Ivan ate greedily and grew at a rapid rate; always active and inquisitive, he reached maturity quickly. Hilda began her sexual cycles early and reached a high level of reproductivity, giving birth to large litters of lusty young. These offspring in turn went through life with a zest and gusto which is possible only in cool surroundings. Such active living requires much energy, however, and necessitates the giving off of large amounts of waste heat. When shifted to tropical heat, Ivan and Hilda were forced to adapt their lives to a more leisurely pace. After about three weeks of heat they ate less than half the food they had in the cool surroundings and their rate of growth was correspondingly reduced. Their cousins, who were kept permanently in the heat, matured late and were of low fertility. Although mating took place just as freely as in the cold, it was difficult to achieve conceptions or to produce healthy offspring. These animals of good stock, kept in the heat but on entirely adequate diets and with perfect sanitation, showed the same high stillbirth and infant-death rates found among human populations in tropical regions where heat conditions are similar.

It is interesting that rats or mice subdued to a slow pace of life by tropical heat live longer and come to old age later than do their brothers or cousins kept in more invigorating coolness. This is true, however, only if they are carefully shielded from all infections and contagious diseases. In the heat their ability to ward off or fight infection is sharply reduced. While living in the cold, Ivan could survive an injection of pneumonia germs which would be quickly fatal to him if he had been living for three weeks or more in the heat. Vaccines also call forth a more active defence response when he is living in energizing coolness.

White blood cells constitute the body's first-line forces in the fight against invading bacteria. At any point of attack they quickly gather in large numbers, to ingest and destroy the invading organisms. Theirs is often a suicidal defence, however, for many of them are eventually killed by the toxins liberated from the bacteria they ingest. These vital single-celled defenders become sluggish in tropical heat, just as do all other body tissues, and sit idly by while invading bacteria grow and multiply unhindered.

Our animals from the hot and cold rooms show striking differences in white blood cell activity when they are injected with living bacteria. In those from the cold room, the white cells spring into vigorous attack almost at once, gathering in and digesting enormous numbers of the invaders; but in the heat the cells remain largely inactive, even though the living bacteria be thick around them. Further chilling of the cold-room occupants, sufficient really to lower the body temperature, renders even those vigorous white cells less active. This effect probably explains why chilling is likely to bring on a respiratory infection, for some of the disease germs are usually present in the nose and throat awaiting an opportunity to attack when the white-cell defenders are sluggish and off guard.

These observations on our thousands of laboratory animals have helped greatly in explaining human behaviour under different climatic conditions. People die early in the tropics from infectious diseases, with few individuals reaching old age. Malaria, tuberculosis, and many other diseases run a much more rapid course in tropical countries than they do in temperate lands.

Strange as it may seem, people in cool climates live longest, but mainly because they are more resistant to infectious than people of warmer regions. Those few tropical residents who do survive to advanced age show much less evidence of ageing in their bodies than is seen in temperate-zone residents of similar years. Their blood vessels show less hardening and are much more elastic than those of people the same age in cool regions where life has been full of stress. With Ivan and Hilda we can quite thoroughly eliminate the infectious diseases and so study the life processes from birth to a normal death. And when we slow down their speed of life by making the loss of body heat difficult in experimental hot rooms, we find that the changes of old age are markedly delayed.

Scientists some time ago put forward the idea that each species of animal, including man, has been allotted a given amount of living—call it a credit balance in the Bank of Life. If this credit is squandered by living at a rapid pace, then life comes to an early end. A less active and more complacent existence, on the other hand, means living to a riper age. We found evidence strongly favouring such a theory when our animals were kept at almost a vegetative level of inaction by a warm environment or driven into a more energetic life by invigorating coolness. Professor McCay, of Cornell University, has produced a similar delay of the ageing process in his rats by underfeeding or limiting the amount of food they have to burn. My rats in the warm chambers eat and burn less food because of the difficulty they experience in getting rid of the waste heat of such burning, while Professor McCay's rats burn less because they are held down to a smaller daily ration. It seems likely, therefore, that Ivan and Hilda must eventually pay the piper for their restless activity and tendency to "burn the candle at both ends." They are cutting many rat-years off their lives by staying up so late for bridge or night-club life, or whatever it is that constitutes exciting diversion for sophisticated rats of this streamlined age. For real contentment and a relaxed existence free from the stresses of effort and strife, they should migrate to the calming warmth of the hot rooms.

With all our laboratory studies on rats and mice we still know little of the diseases which normally cause their death. Usually we lose interest in them when they have given us the answer we seek for a particular problem. We did, however, watch one large group of cancer mice from weaning time to death. Every mouse was examined for the exact cause of death. Quite unexpectedly we obtained very valuable data on pneumonia in relation to temperature change. In the third of the group kept at 90-91° F. there were no pneumonia deaths, and among those at 65° F. there was only one. These artificial climates were steady and unchanging, but the rest of the mice lived outside the controlled chambers in regular laboratory air at more variable temperatures. Thirteen out of sixty-six in that group died of pneumonia! This finding agrees well with observations on human respiratory infections such as colds, sinus infections, and pneumonia, which—as we shall see in later chapters—are linked to sudden storm changes in the weather.

Rabbits have also played a useful part in our studies of climate. They showed us that individuals adapted for weeks to tropical heat stand chilling very poorly. Their body temperature drops rapidly; they are prostrated by the cold well before those accustomed to cool surroundings show noticeable effects. They seem unable to speed up the burning of food stored in their tissues quickly enough to prevent chilling. Among rabbits previously adapted to colder, more stimulating environments, tissue fires are at once fanned to a brighter flame by outside cold and practically all stored food is used up before the body temperature begins to fall.

Exposure to great heat, however, handicaps the vigorous cold-room animal most severely. He cannot slow down his internal heat production quickly enough to avoid fever and heatstroke, and is overcome by heat which fails to bother his warm-room cousins. Parallel conditions exist among men and women. Human deaths from heat stroke occur not among tropical populations but rather among the more vigorous people of temperate regions during the severe heat waves of summer.

Nature equips her children with ingenious heat-eliminating mechanisms to reduce the chances of such serious upsets. Ivan, for example, lacks sweat glands in his skin; but he possesses a special heat-loss organ of great value to him in periods of stress. That long tail of his is not as useless as it appears! It is warm with a rich blood supply when he needs to lose more heat, becoming cold and pulseless when he feels chilly and has to conserve calories. The tail of a rat reared in the cold with small need for a heat-loss organ is distinctly shorter than normal, while in a warm environment it grows long and tapers to a fine point. Successive generations raised in the cold have shorter and shorter tails, a fact which perhaps offers a clue as to why man lost his tail. Not long ago I read a news report about a native in the jungle heat of Brazil who had grown a considerable length of tail at the tip of his spine! The report failed to state, however, whether this gave him any important advantage over his tailless neighbours.

Rabbits also have a specialized part of the body for heat loss. Those long ears are useful for other purposes than hearing—they are really radiators. The ears of rabbits reared in a warm environment have 25 per cent. more surface than those of cold-room animals, despite the fact that the total body size is much smaller. As with the rat's tail, a rabbit's ears are gorged with blood when the animal has difficulty keeping cool, and quickly become pale and cold when he begins to chill. Perhaps it is the mule's long ears which enable him to keep on working in severe summer heat better than the horse. And the way he flaps them back and forth may be not just an expression of his droll humour, but a means of losing more heat from their broad surfaces. If you suspect your own infant of being chilly, what do you do? Put your hand on his ear. If it is cold he needs more clothing or bed covers, even though the rest of his head may be warm. His toes get cold at about the same time as the ears, when he is withdrawing blood from his most exposed parts to slow down heat loss.

Although I myself have not delved into the privacy of Ivan's mental processes, a scientific friend in another university has done so with astonishing results. He raised rats from birth at three different temperature levels, 65° F., 76° F., and 90° F. As young adults they were tested for their learning ability. Those adapted to stimulating coolness required 12 trials, on the average, to learn their way through a labyrinth to the spot where their food had been placed. Those raised in moderate warmth learned their way through in 28 trials; but the lazy ones reared in tropical heat had great difficulty in solving the problem. Those which did find their way through required an average of 48 trials, but many of them simply gave up and quit trying.

His cold-room rats would dash through the mazes with never a wrong move, once they had learned the proper turns to take. Their memory signposts seemed to mark the way in clear fashion. The intermediate group made more frequent errors even after having found the proper path. But with those from tropical heat, progress continued to be pretty much of a hit-and-miss affair even after they had once got through. When retested after a three-months rest interval, the cold-room rats remembered the proper turns with almost no hesitation, the 76° F. ones had forgotten somewhat, and those from the heat seemed to retain no knowledge whatever of their former experience—they had to start all over again.

Thinking is really work in energy terms, for the grey matter of the brain uses oxygen and burns food far more rapidly than any other tissue of the body. In my own case I find it difficult to do mental work in tropical warmth, where such effort is almost as effective as physical exercise in bringing on profuse perspiration. The manual labourer, therefore, cannot claim that he does all the world's work.

Intelligence and aptitude tests show that college students, like rats, think poorly in the heat, for scores are lower in summer than in winter. This is particularly true in the South, where summer heat is prolonged and depressive, but even as far north as Indiana and Illinois, summer test ratings slump below those of winter. In the northernmost tier of states, however, truly depressive heat seldom occurs and test ratings are uniform throughout the year. So, Hilda and Ivan, when you must face a difficult problem or come to a decision of great importance to your future, seek a cool and secluded corner for your thinking.

Our two laboratory helpers—and their near and distant relatives—have helped us reach a clear understanding of how climate dominates life. In cool surroundings, where body heat can be lost with ease, health assumes an extremely positive and buoyant character. The daily pace is swifter. More work is accomplished. But the heightened tempo means a faster reduction of the credit balance in the Bank of Life. Certain real dangers accompany this more dynamic, cool-climate existence—dangers of early exhaustion or breakdown of the body machinery. In warm environments health assumes a negative, passive quality. Most of life's dangers arise from a lowered vitality and lessened resistance to infection. Difficulty in losing body heat seems inevitably to bring a slower burning of food in the cells and less energy for living. Growth is retarded and in every way existence drops closer to the vegetative level.

These conclusions are naturally based on more than animal experiments. We have checked and cross-checked the findings of such tests with actual observations among living things "in the field." It so happens that the rats, rabbits, mice, and other animals have not informed us wrongly. Their reactions under artificial conditions correspond to actual reactions as noted by myself and other scientists during wide travels in different locales and climates throughout the world. The following chapters will tell the story of what we have found in the lands outside the laboratory, but do not forget our debt to Hilda, Ivan, and their fellows, who provided clues and confirmations in the rigidly controlled climates of their hot and cold rooms.

CHAPTER 3

FARM ANIMALS IN THE TROPICS

OUR HELPERS IN THE LABORATORY are not the only animals to furnish vivid evidence that life is under the influence of climate. Temperature also plays a vital role in the growth of the farm animals which help provide man with food. Judging solely by what Hilda, Ivan, and their relatives have shown us, we would suspect as much, but there is considerable further proof to support such a conclusion. Several times I have encountered hints that animal husbandry is severely handicapped in tropical surroundings, and last year I had an opportunity to make first-hand observations of this phenomenon when I visited Panama and the Canal Zone at the invitation of the Gorgas Memorial Laboratory in Panama City. My studies of domesticated animals included investigations of conditions on cattle ranches and hog, poultry, and dairy farms.

The effect of climate was vividly demonstrated at a large hog farm a few miles outside Panama City, where I almost lost my taste for pork—at least the local variety. As our car approached the feeding yards, a large flock of buzzards rose from the ground and flew off to perch in near-by trees. They had been feeding on the decaying flesh of the pigs which had succumbed to the heat. The sickly, puny little pigs wandered around everywhere, half of them to die before reaching adult size, while meat-supplying porkers wallowed in the garbage tanks to keep cool. Although I am accustomed to the hog as a dirty animal, the buzzards and the garbage almost turned my stomach.

I learned with great interest that Panama places a five-dollar penalty on the killing of its carrion birds. They were everywhere, even in the city yards. I often watched them from my window as they fought over the food of the laboratory dogs. They serve a good purpose in the jungle country, for otherwise animal carcasses might quickly pollute whole neighbourhoods in the prevailing heat. Until I heard of the legal penalty, I wondered why these birds should be so much more numerous in Panama than in any other country I had visited. Never molested by men, they show little fear, but a rather gruesome touch is added to one's impression of a country by seeing everywhere their death-watch circling and hearing their raucous cries as they tear apart the rotting corpses.

Hogs, like chickens, are quite severely affected by hot weather. They have no sweat glands and so wallow in the mud to keep the cooling layer of moisture on their skin surface. Early in life I learned by painful experience that hogs do not smear themselves with mud as an idle pastime during hot weather. One summer when I was eight years old my father was fattening about a hundred shoats for slaughter. In the wood lot back of the barn on our Indiana farm there was an old gravel pit almost filled at one end with muddy sediment. I learned to skate there in winter, swim in summer, and fish in other odd moments. There, too, the hogs loved to wade in hot summer weather. The water was not entirely stagnant, for a small brook flowed through the gravel pit. Early each morning we fed the hogs corn in a separate feeding lot, with the gate to the water hole closed to keep the cattle away. This gate was always opened as soon as the hogs had eaten, so they could cool themselves in the water during the heat of the day.

One August morning my father had to make a trip into town and asked me to let the hogs out of the feeding lot as soon as they had finished eating. The day was clear and the sun hot by ten o'clock in the forenoon, but by that time I had forgotten all about the hogs in the feeding lot with no water to wallow in. Peaches and summer apples were just ripening. What fun it was to pick out the good ones and munch on them in a cool spot of orchard shade! But the shoats had no shade. I suddenly remembered the gate when I saw my father returning from town, but by then eight of the hogs were already dead from the heat, and many others were prostrated. Those still able to walk rushed for the water when we at last opened the gate, and waded in up to their snouts. We managed to rouse some of the others with sticks and drive them down to the gravel pit. A few of the prostrated ones were hauled to the water upon the little stone sled used for clearing glacial boulders off the fields. In one frantic hour we saved all the hogs not already dead on my father's return. It took another two hours of hard work to bury the unfortunate eight that had died while I munched apples and peaches in the orchard.

I recalled this sad experience vividly as I watched the Panama hogs wander sluggishly in the midday heat. It was the dry season, and they had no place to wallow except the concrete garbage pits. Little pigs seemed to suffer most from the heat. I suspect this was the main reason why so many died and the survivors looked stunted. The flock of carrion birds always hovering over the farm only deepened my feeling that life for these hogs was never far separated from death. How different was this picture of sluggish stupor from that of the pushing, squealing, fighting hogs on our northern farms! The enervating effect of heat is one reason why it took 12 to 15 months to produce a 200-pound porker on the Panama hog farms, while animals of the same weight can be grown in 6 or 7 months in northern parts of the United States. Although 200 pounds is about the largest size reached by tropical hogs, in the North they grow to twice that weight by the time they are two years old.

Even in our southern states, where coolness prevails six months a year, depressive summer heat provides a distinct handicap for domestic animals. Early last October I visited the animal farms of one of the leading agricultural colleges in the South. There I found a caretaker turning the hose on a group of shoats being fattened for the fall market. How they did like that cooling spray after being out in the hot midday sun of the open fields! With such *de luxe* service hogs do fairly well through the summer heat, but the ordinary farmer cannot give them this luxury. His hogs must seek their own wallowing facilities wherever they can find available water.

The Hereford cattle on the experimental farms were also panting in the hot sun, with fever-hot skin and listless attitude. They stand the heat more poorly than do the Brahman cattle of India origin. Ranchers of the Gulf coast have found these zebu or Brahman cattle much more resistant to heat than the Hereford or Angus breeds. While the latter two kinds develop several degrees of fever as they pant in the hot summer sun, the Brahmans continue their grazing at a normal body temperature. Adaptation to the heat of India through untold generations has given them the same sluggish metabolism which hot-room animals developed in the laboratory. Along with their resistance to heat, however, goes the same slowing of growth I found in our experimental rats and mice. While it takes only 1½ to 2 years to produce a 1000-pound steer in the northern United States, Brahman steers along the Gulf coast are not ready for slaughter until they are 2½ to 3 years old. The situation is even worse in the tropics. One of Panama's most progressive cattle ranchers showed me his miles of range and thousands of cattle. He had special pastures of Pará grass for the final fattening of steers, but even under these conditions he needed about four years to make a 1000-pounder ready for slaughter. Canal Zone authorities later told me that steers from Cuba, Colombia, or Panama—

imported to the Zone for slaughter—did not reach the 900-to-1000-pound stage until they were 4½ to 5½ years old.

I also visited the large Mindi Dairy which supplies the major part of the milk in the Canal Zone. About 1400 cows are kept on concrete floors to prevent parasitic infections. They feed almost exclusively on selected feeds imported from the United States and mixed on the same scientific principles which are applied to the nutrition of northern dairy herds. Most of the cows are imported directly from the United States because experimental breeding had shown that the Panama-born offspring of American cows are inferior milk producers. Even so, these imported cows yield only about three-quarters as much milk as similar stock in the north. At that time milk from this Canal Zone herd retailed at 18 cents a quart, so you can see that quality production is costly in those sections.

Tropical heat not only directly slows the growth and productivity of the farm animals which feed man, but also results in inferior grasses and other plants which feed the farm animals. The hogs so affected by hot weather on the farm near Panama City received little fortification from their chief food, fermented Canal Zone garbage. It contained plenty of vitamins A and C, perhaps, but insufficient quantities of the vital B-complex fractions. This deficiency is a particularly serious one, because the B vitamins speed up the burning of food and help counteract the sluggish effect of climatic heat. I have a brother who raises hogs in South Dakota where all animals eat and grow with real zest; but even there it was found helpful to add to the wheat-and-corn mixture a small portion of alfalfa leaf—an exceedingly rich source of the B vitamins. My brother thus obtained much faster growth and more pounds of pork per ton of feed. Neither alfalfa nor the vitamin-rich cereals and grasses grow in tropical heat. Native forage is coarse and full of fibre, and therefore stock-raising is carried out under severe handicaps.

There is an interesting relationship between the rate of animal growth and the quality of the grasses eaten. As was mentioned earlier, it ususally takes less than two years to raise a 1000-pound steer in the northern states, from 2½ to 3 years along the Gulf coast, and up to 5½ years in the tropics. Correspondingly, Gulf coast pasture grasses are not as coarse as those of Panama, but neither do they have the fine texture of northern varieties. Heavy rainfall throughout the spring and summer makes coastal grasses coarse and reedy, and during the wet haying season farmers find it almost impossible to cure their crop without having it spoiled by heavy dews or rains. Northern farmers often discard hay which is rained on between cutting and stacking because so much of its vitamin and mineral content is lost in the wetting; but in the South the farmers have no choice. The animal husbandry professor at the southern experimental farm pointed in disgust to the poor quality hay he was feeding to his pure blood Hereford bull—it was brown, coarse stuff which a northerner would use only as winter bedding for his stock.

Since slow-growing tropical farm animals eat grasses low in vitamin B content, we would expect their meats to show a similar deficiency. Desiring more accurate information on the vitamin content of meats from various climates, I arranged to have animal products collected in Panama, along the Gulf coast, and in the northern United States. The products from these three sources are at present being analysed for their B vitamin content. Although the study is still incomplete, it is already evident that the tropically grown meats contain less of these vitamins than do the meats grown in the North.

Eggs from Panamanian hens fed in the usual hit-or-miss fashion are likewise low in vitamins. But if the hens are fed imported mash used by American poultry growers, the eggs are almost as rich as those of the North. Other investigators had previously found the vitamin content of eggs to be affected by food intake. Studies on the Gulf coast of Texas also have shown considerably less vitamins in the meats of that region than of Wisconsin. The evidence suggests that, hereafter, when you go out to buy your eggs or meats, you will obtain a better bargain if the products come from farms where animals are cool and well fed.

The dismal tale of tropical foods is not finished yet. I had often wondered why meats served in the tropics required so much chewing until I found that hot-climate steers are not ready to be slaughtered for about five years. That explained the mystery—the steers were old and tough before they were large enough to kill! Most tropical dwellers seem to like their meat tough, but I prefer tender juicy steaks from fast-growing northern steers. I actually timed myself on the mastication of a particularly tough steak served one evening in the hospital. Parking the bite of steak in my cheek while I ate dessert, I finished the job during a stroll along the nearby sea wall. It took eighteen minutes of active chewing before that one bite was in fit shape to be swallowed. Perhaps the loss of a few molar teeth has handicapped me somewhat in eating tropical meats, but I find plenty of understanding listeners to my tale of woe.

True to the general tastes of tropical natives, Panamanians liked tough fried steaks, but most of the meats served were actually tender because they had been cooked for a long while. This practice provides the crowning point of a situation in which everything seems wrong. It is not enough that tropical animals grow slowly because of the heat and vitamin-poor foods, or that their meat is consequently tough and stringy by the time they are of slaughter size. But long cooking calculated to tenderize the meat adds insult to injury by destroying a large part of the meagre vitamin supply it naturally contains. In fact, sufficient cooking to make the meat tender reduces its previously low vitamin content almost to the vanishing point.

It is clearly evident that people of the tropics face a nutritional problem of serious proportions in their vitamin-poor meats and other animal products. They can ill afford to import the rich stock foods used in temperate regions; indeed, it would be more economical to let the crops be used where they are grown and import the finished animal products for consumption in the tropics. Such importation is much simpler to-day than it was a few years ago, because refrigerated holds in ships and cold-storage space in tropical cities are far more common.

Only a few years ago in Manila I was much amused at the way hostesses competed for guests at dinner parties which they wanted to hold the day after a fresh supply of choice American beef had arrived in port. Even in many restaurants of our southern states recognition is given to the poor quality of native beef. While driving from Cincinnati to New Orleans, my wife and I once stopped in southern Alabama to order dinner. The menu listed western steaks at 75 cents and native steaks at 50 cents. Needless to say, we chose the western variety.

Although tropical countries should encourage importation of meat from temperate regions, they have instead erected high tariff barriers to protect the native stock-growers. Perhaps a clearer insight into what good meats mean in terms of health will eventually lead to a more intelligent handling of the matter.

Climatic dominance over domestic livestock seems to be just as great as it is over our experimental animals in the laboratory and over human beings in different regions of the earth. Proper ease of body heat loss is everywhere the first requirement for rapid growth and high vitality. All conditions seem to favour life in middle temperate coolness—grain and forage crops growing in abundance, good conditions for proper harvesting, and the final meat products rich in much-needed vitamins. In these climates, conditions are favourable for the best development of all warm-blooded species. The more vigorous tissue fires seem less affected by occasional vitamin lacks which may be encountered by men and animals from time to time.

All persons considering entrance into the livestock business, take notice. See that the location you choose has proper temperature conditions. Avoid exposing your animals to the chilling cold of winter or the devitalizing effects of severe summer heat. Dairymen know that proper care of the milk-cow pays good dividends; the same is true of poultry growing, and it also holds for the raising of larger meat animals. Well-watered pastures are a great boon in summer, but no more so than warm barns in winter. Keep your laying hens at the right temperature and they will produce well when those of your less careful neighbours are on enforced vacations—and the price of eggs is high.

Animal husbandry experts of our southern states, of South Africa, and of other subtropical regions are now giving serious thought to these phases of their problem. The matter has become more urgent for them now that heat has been shown to make their meats poor in much-needed vitamins. Their problems are closely bound up with those of human nutrition since temperatures found best for animals are also good for man. In addition, we shall see that tropical man stands in great need of the vitamin-rich meats so difficult to produce in this climate.

CHAPTER 4

VITAMINS AND CLIMATE

AS THE SPOTLIGHT OF TROPICAL studies sweeps past animals and focuses on man himself, we find a wealth of new information and an urgent need to apply such facts to many practical problems. The tropics, formerly suggestive of exciting explorations and big-game hunting, are now important as places of military and strategic significance which have to be defended or won back from Axis armies. Java, Bali, Ceylon, Madagascar, and other once romantic places have had first-hand experience in the business of waging a war or preparing for attacks. The working efficiency of fighting men, natives, and non-combatants all depends to a large degree on climate, for tropical temperatures affect a thing very important to man—his diet.

Although it has long been known that people should cut down on fats and large meals in general during hot weather, recent studies show that climate also affects man's B vitamin requirements. Of course, fruits and vegetables fresh from the garden are desirable for supplies of vitamins A, C, E, K, and necessary minerals, but in order to obtain the B fractions so important in maintaining the tissue fires we need meat and more meat. Beefsteak in hot weather! Not necessarily—cold cuts are just as effective, especially liver sausage.

In the previous chapter we indicated the importance of the B complex from a climatic and seasonal point of view. These vitamins, like climate and weather, play a direct role in the burning of food for human energy fuel. They act somewhat like the tetraethyl lead added to automobile gasolines. The lead compound serves as a catalyst which gives more even and complete burning of gasoline in the cylinder chambers. The result is greater power and elimination of the knock frequently heard when raw gasolines are used. The B vitamins are the "tetraethyl lead" in the burning of our foods. The combustion must go on by slow stages so that too much heat is not produced at any time. The blood and blood vessels act as our cooling system to carry waste heat from cells to skin surface, and this system must not be overloaded.

Slow burning of our food is made possible by the B vitamin catalysts, each of which controls one small stage of the oxidation inside the cells. The energy liberated by this gradual burning of food is thus available to run the body machine without the dangers of overheating which would result if the fire burned more vigorously. Inadequate supplies of the B vitamins mean slower and more faulty burning in the cells and less energy on which to live. Apparently, smaller amounts are needed in each pound of food eaten by people of cool regions, where tissue fires burn more brightly. With the more sluggish combustion of tropical inhabitants, larger amounts of these vitamin catalysts become especially important. Their life is already severely handicapped by the body's difficulty in getting rid of its waste heat, so it is doubly essential that the greatest possible efficiency be maintained.

This simple explanation of the function of B vitamins leads us logically to expect that tropical dwellers would need a larger daily amount of these food factors than people in cooler climates. But logic alone is not enough, and, as has happened so often, Hilda and Ivan and their relatives gave us the first concrete evidence that such an extra need actually exists. Food mixtures containing enough of the B vitamins to bring cold-room inhabitants a long and healthy life left hot-room adults runty, stunted, and prematurely wizened. In fact, our tests showed that in order to grow normally rats living at the summer temperature of 90° F. needed twice as much of the best-known of the B vitamins, thiamin (also called vitamin B_1), in their food as did a group of their fellow rodents placed in a room at 68° F. Moreover, other tests showed how rats fed low thiamin diets differed in personality depending upon the temperatures of their homes.

Our rats on special diets are given food in glass jars placed inside the cages, so that they may eat as much as they wish. When we are not especially interested in dietry studies, we give them dog chow biscuits which contain an abundance of all food elements. These are placed in a wire bin in one upper corner of the cage, with an opening above for easy replenishment of the supply. The rats gnaw on the biscuits through the wire mesh whenever they like. The chow is excellent food and is eaten with relish.

One of Ivan's cousins on a low thiamin diet in the cold room displayed most amusing cleverness in taking proper care of his food requirements. After about two weeks of deficient meals our canny friend decided to do something about the sad state of affairs. One night he determinedly pushed open the door of his cage, and we found him next morning with his house packed full of chow biscuits stolen from rats some distance away. Showing shrewd planning ability, he had pushed his own food jar out to make more storage room. There he was contentedly sleeping in one little corner, with the rest of the cage chock-full of chow. No more starvation diet for that fellow! His body weight that morning showed that he had not spent the whole night filling his cage only, but had gorged himself as well. He was quite good-natured about it as we emptied his cage and replaced the jar containing the special deficient diet, although he probably had his own opinion about our wisdom.

Before this episode he had begun to lose weight, but now he gained rapidly for the next week and a half. He really must have filled up that night! Two weeks later, when he had started losing weight again on his deficient diet, he broke open the door of his cage a second time and repeated the chow-stealing performance. Later he did it a third time. That cold-room rat was displaying the same aggressive ingenuity and industry which has prompted people in cool climates to develop a high civilization and accomplish near miracles. Just as a check one night, we intentionally left the cage door open for another rat on a deficient diet. He duplicated the performance of our keen-witted friend. But when we left the door open for cold-room rats whose diet already contained adequate supplies of vitamins, there was no apparent interest in the chow biscuits.

Hot-room rats on diets deficient in thiamin take life much more contentedly. Far be it from them to push open the cage doors and seek a more adequate diet. Even when the door is left open for them they are too lazy to seek the nearby supply of better food. They demonstrate the tropical resignation and lack of initiative which keeps large sections of the human race content with a low level of existence.

Young chicks—little white Leghorn cockerels—kept in my hot room also need extra supplies of the B vitamins. They develop beriberi convulsions at dietary levels of thiamin upon which chicks in the cold room grow and thrive. Another less well-known B vitamin is even more important for existence in the heat. This is choline—a distant relative of the bile acids—which we obtain mainly from animal products. Rats need five times as much of it at 90° F. as at 68° F. Placed on diets containing no choline, they quickly develop a highly fatal hæmorrhagic condition of the kidneys in either hot or cold environments. Such kidney trouble—acute hæmorrhagic nephritis—is an important and rather common cause of death among tropical residents and may be found to be based upon the relative choline deficiency existing in the heat. Brains, sweetbreads, and kidneys are our richest food sources of this interesting substance. Others of the B vitamin group show a higher requirement in tropical heat, but none in such striking fashion as choline and thiamin. Most young rats placed on choline-free diets die in about eight days; without thiamin they live three or four weeks; but complete lack of any single one of the other B fractions is less fatal, usually causing only slower growth and stunted development.

Since our hot-room animals needed larger amounts of the B vitamins, I decided to find out whether the same requirements held for human beings in the tropics and planned my recent trip to Panama and the Canal Zone for that purpose. The result was a wealth of interesting information which showed the existence of a widespread B vitamin deficiency. This situation, plus the evidence provided by Hilda, Ivan, *et al.*, indicates that such a lack is probably common to residents of all tropical countries.

My trail, as in the animal husbandry studies, led to the Gorgas Memorial Laboratory in Panama City, which was established in memory of General Gorgas, the man responsible for cleaning up the Canal Zone in its early days. It was he who showed that most tropical diseases could be banished by proper sanitation, thus making it possible for the white race to live and work there in good health. In recent years, however, the belief has been growing that tropical climate itself has an enervating influence on man, even after the infectious and parasitic diseases have been largely eliminated. That this weakening effect is partly due to a deficiency of B vitamins, which is aggravated by enervating heat, soon became evident as a result of my studies.

One important clue was furnished in the case of a young woman suffering severely from a lack of thiamin. A daily dose as small as a tiny knife-point would have kept her in good health, but when I saw the patient, she lay paralysed—a complete invalid. Born and raised in Panama, she had been a talented dancer until stricken. In September she had gone into the hospital for an abdominal operation which was satisfactorily performed. After leaving the hospital, however, she was bothered by nausea and inability to eat or retain her food. In October she suddenly developed beriberi, with swelling of her whole body. In the hospital she was given thiamin and the swelling promptly subsided. But a week or so later, she developed the paralysis and loss of sensation in all her extremities which sometimes occurs in this vitamin-deficiency disease. When I saw her four months later, she was slowly regaining use of the muscles in her arms and legs, although still unable to walk alone.

Only a few years ago, beriberi annually killed tens of thousands among the rice-eaters of tropical and oriental lands. With a diet very largely made up of polished rice, these people unwittingly discarded the parts of the kernel containing the B vitamins so essential for health. Even after it was clearly shown that use of unpolished rice would prevent or cure beriberi, many millions still continued eating white rice. In temperate lands a similar situation exists in the use of wheat. Most people prefer white bread, even though they know that the greater part of the wheat vitamin has been discarded in the flour-milling process. The bran and middlings, so rich in these necessary substances, are largely used as stock food while we keep for our own use the vitamin-poor white flour. In many countries serious consideration is now being given to measures which will prevent this vitamin loss in flour making, but beriberi is rare in temperate climates.

It was not merely by accident that this disease struck down the young woman in Panama. Such severe trouble from lack of thiamin is common in tropical heat. She was advised to leave the tropics for a more energetic life in the northern United States, where vitamin deficiencies are less prone to occur. At the last report she was recovering rapidly in New Jersey.

To find whether B_1 or thiamin deficiency occurred among persons in a subclinical form—that is, without showing actual symptoms—I prepared to make a series of special tests during my first week in Panama. Man normally discards through his kidneys part of the vitamins taken with his food. If his vitamin supply is ample this excretion is high, while on deficient diets it drops to progressively lower levels. With thiamin, the normal day's excretion is 100 to 500 micrograms (thousandths of a milligram). A rate below 100 micrograms is taken to indicate an inadequate supply in one's food.

My first thiamin determinations were strictly a family affair. My wife and our thirteen-year-old son accompanied me on the trip, and while in Panama we were housed and fed in the Panama Hospital just across the street from the laboratory. The food was almost entirely native in origin except for such staples as sugar, flour, and salt. A plentiful supply of meat was served, but it was locally produced, as were our daily breakfast eggs. After three weeks of this hospital diet our thiamin excretion rates had dropped from the 400- to 600-microgram Cincinnati level to less than 100 micrograms a day.

Various other people living on native foods were found to have similar low excretion rates. Native helpers in the laboratory, hospital patients with inactive tuberculosis, and inmates of a leper colony outside the city were all living at this deficiency level. Meats from Argentina or the United States are extremely expensive in Panama because of the high import duty, but people with Canal Zone Commissary privileges avoid these duties. Several of my human guinea-pigs used these imported meats instead of the local products, and in every case the thiamin excretion rate was considerably above the 100-microgram level. Some of us with low rates first tried a good helping of native pork loin, and then, a few days later, a similar helping of loin imported from the United States. Our thiamin elimination was almost twice as much after eating the imported pork as after the native product.

Meats are mentioned so frequently because they normally provide us with the greater part of our B vitamin supply. Liver is a particularly rich source, while lean pork, whether cured or fresh, contains several times more thiamin per gram than does lean beef, chicken, or fish. But it is not much richer in the other B vitamins than other meats. Additional important natural sources for the B vitamins are unprocessed cereal grains—rice, wheat, oats, and rye. But Panamanians, like all persons who do not eat many unprocessed cereals, must rely mainly on meats and other animal products for their B vitamins.

It is particularly serious that hot-climate livestock should yield meats low in such essential elements. As we might expect from the findings in the last chapter, meats grown in Texas and Louisiana, as well as in Panama, are poorer in vitamins than cuts from livestock in the northern United States. Panamanians require an especially high vitamin B intake, but their meats are deficient from this standpoint. The beneficial effect of cooler-climate meat can be clearly detected. Time after time I observed the thiamin elimination jump from a 100-microgram level to 600 to 800 micrograms after a single helping of liver, ham, or imported pork loin. One of my scientific friends in Panama had been eliminating thiamin at the 100-microgram level, but his rate suddenly rose and continued at about 250 micrograms. Close inquiry revealed no change of any sort in his diet except a shift from ordinary Panamanian eggs to those from a poultry farm where all the hens had been imported as chicks from the United States and fed only on a scientifically mixed imported feed mash. Two of these eggs for breakfast had definitely improved the man's thiamin status. After this experience he decided he would like to take the thiamin "straight" in tablet form. Three milligrams a day—about the normal requirement in northern climates—quickly raised his excretion to about 1500 micrograms.

Even while my son and I were losing less than 100 micrograms daily, the taking of 3 milligrams of thiamin by mouth would raise our rate to about 1500 micrograms within a day's time. This indicated that our tissues were still well saturated with sufficient vitamin stores. The natives we studied, however, had been on inadequate diets for years and needed 3 milligrams of thiamin daily for 6 to 8 days before their tissues became saturated and their excretion rate rose to a 1500-microgram level.

Laboratory workers who volunteered as experimental subjects unanimously reported that 3 milligrams worth of thiamin tablets daily increased their energy and made them feel better generally. The rat experiments indicate that the men would have benefited even more if they had doubled this dose. But our work in Panama also revealed the important and hitherto unsuspected fact that overly large doses may actually poison the system. My wife was case No. 1. She had become quite ill after taking only 10 milligrams daily for 2½ weeks, developing severe headache, restlessness, insomnia, rapid pulse, weakness, and prostration. Her symptoms cleared up within two days after she stopped taking the tablets. A week later she began taking 5 milligrams a day, and suffered a recurrence of the same complaints at the end of 4½ weeks. This experience put me on the alert to spot similar ill effects during my stay in Panama, and in a lecture before a group of physicians there I described these symptoms of apparent thiamin poisoning. The next few days brought numerous reports of just such reactions, which had not previously been attributed to thiamin because specialists believed it to be entirely non-toxic, even at daily dosages of 500 milligrams.

Since returning to Cincinnati, I have received many reports of even more serious reactions to thaimin overdosage. Several bad reactions have followed its injection in 10- to 50-milligram dosages, and one death has been reported. But all patients who suffered ill effects from overdosage could readily take 2 to 3 milligrams a day to cover their actual needs. The discovery that too much thiamin may be harmful emphasizes one danger of the current vitamin craze which grew up before all the research results were in. Recent findings of new vitamins and their important functions in the body have been exploited rapidly in both the lay and the medical Press. Even physicians have come to regard vitamins as an almost universal panacea and have sold this idea to the public at large. That they did an excellent selling job is illustrated by the fact that Americans spent more than $100,000,000 in 1940 for pills and other vitamin preparations.

But all-out enthusiasm is usually premature. Thiamin is probably the most commonly used drug in America to-day. Its popularity, and consequent large-scale production, has brought enormous profits to the large chemical concern holding the basic manufacturing rights for its synthesis. Specialists studying deficiency diseases in the United States had been resposible for advocating large dosages; the only limiting factor seemed to be the price of the vitamins. And as the cost of thiamin was reduced from 5 cents a milligram to only one-fifth of a cent, the size of prescriptions rose accordingly. Daily doses of 30 to 50 milligrams became common, even 500 milligrams being used in certain instances.

Panama physicians only followed the lead of their American colleagues in prescribing many times the amount of thiamin needed by the healthy body. It was rather common practice to give 20 to 50 milligrams a day in an effort to overcome the physical let-down so often encountered by people migrating to the tropics. The young woman patient mentioned earlier in this chapter was taking an average of 17 milligrams a day and had previously received much higher doses. But our discovery shows that such measures probably did more harm than good. As a result of this work, physicians in the United States and Panama have become more conservative in prescribing thiamin and are keeping dosages down to nearer-normal levels.

Although extremely large daily doses of thiamin may be poisonous, there is little danger from enriched white bread as long as federal authorities strictly forbid addition of the vitamin in excess of the whole-wheat flour content. Such rigid control is also necessary over fortification of white sugar and other foods which have lost their natural vitamins because of processing methods. It should be remembered, however, that 2 to 3 milligrams of thiamin in northern climates and about double that figure in the tropics are safe and necessary for health.

I've often wondered whether there might be good reason why residents of tropical and subtropical lands like most of their foods well seasoned with plenty of pungent spices and condiments. Most spices are ground from small seeds rich in B vitamins, so here may be an unwitting effort to remedy a dietary defect. Spicy foods also stimulate freer flow of hydrochloric acid in the stomach secretions, and here again is an effect particularly needed in hot climates. Hot weather inhibits the normal production of acid. The food in the stomach digests more slowly and is more liable to bacterial spoilage. So don't stint on the spices for hot-weather use!

I have said little of any vitamins except those of the B group. This has not been because others are not just as necessary for our welfare but rather because we yet have no evidence linking them so closely to climate. Lack of vitamin C caused thousands of deaths from scurvy among seamen during the long sailing voyages of two centuries ago. The discovery that lime juice would protect them from this ailment, and its enforced use on British ships, resulted in the nickname "limey" for British sailors. Vitamin D, necessary for proper use of calcium and phosphorus in the bones and teeth, has also never been shown to be affected by climate. But there is much evidence of rickets among Panamanian children, even with all the bright sunshine. Close study might reveal that people there require more of this vitamin, just as they do of the B fractions.

But the need for further study must not hinder the application of knowledge already gained. Enough B vitamin facts have accumulated to warrant specific steps in solving immediate problems in the world outside the laboratory. In temperate-zone climates, human needs are well known but not widely applied. Two quarter-pound servings of northern lean meat (one beef and one pork)and two eggs a day would give you roughly 2 milligrams of thiamin, 1·5 riboflavin, and adequate amounts of pantothenic acid, nicotinic acid, biotin, pyridoxine and the lesser-known B fractions. A quarter-pound serving of liver contains more than the total daily need for all the fractions except thiamin, and might well be eaten at least once or twice a week to provide an added factor of safety. Fresh fruits, vegetables (especially the legumes), and cereal foods supply considerable quantities of thiamin and riboflavin; but for most of the other B fractions we rely chiefly on animal products.

Since prolonged cooking destroys much of the vitamin content of food, eat raw fruits and vegetables as often as possible. Quick cooking of meats gives least destruction and prolonged stewing most. If vegetables are boiled, the water should be served with them, for it has extracted much of the vitamin content. And do not add baking soda to keep the vegetables green, for this destroys the vitamins almost at once.

Yeast has been widely advocated as one of the richest B vitamin sources, but for many of the fractions, liver and egg yolk are about as rich and much more palatable. I must admit that so far I have not been able to find an entirely satisfactory way of taking yeast in the amounts needed. A great many people build up an active dislike for its taste, and it often causes digestive discomfort. In every way it seems wiser to obtain the B vitamin supply from regular food.

Special suggestions are naturally pertinent for special conditions. Wherever body heat loss is made difficult by high temperatures, there extra supplies of the B vitamins are of tremendous value in making the fires of life burn more brightly. Industrial workers in boiler rooms and other hot environments have found their duties less exhausting after taking 5 to 10 milligrams of thiamin daily. Men labouring in the holds of naval and merchant ships would be similarly protected against the debilitating effect of heat by such doses. The efficiency of these workers in the vital war effort would probably be even further increased by the consumption of more meats and other animal products. The old ideas about avoiding proteins in hot weather should be cast aside. Our rats need the same percentage of protein in their diets at 90° F. as at 68° F., when their B vitamins are supplied in pure form separately from the protein. Unless you eat pork almost every day, or use whole meat or enriched bread, it is probably wise to take a few milligrams of additional thiamin in pure form during the hot summer months. But if the B vitamins are to be obtained from natural foods, there is need for a larger proportion of the vitamin-rich proteins in summer than in winter diets. Since less food is desired in hot weather, the dietary items selected should be especially rich in all these vitamins. Increased needs will be met by liberal consumption of meat, eggs, cheese—and liver as often as possible.

We people of the middle temperate regions are exceedingly fortunate in many ways. Except for hot spells and peculiar occupational conditions, cool surroundings enable us to maintain a high combustion rate in our tissues and thus to have an abundance of vital energy. Although our tropical brethren are not so fortunate, perhaps the day is near when they can enjoy the riches of their homelands without their age-old sacrifice of vitality. We now know that growth and vitality in animals can be kept almost as high in hot as in cold climates, provided the proper excess supply of B vitamins is maintained. The possibility that similar benefits would apply to man was indicated among our laboratory assistants in Panama, who reported that they felt more vigorous and wide awake while taking thiamin. My egg-eating friend decided to find out whether a few milligrams of this B vitamin factor would give him more energy. It did. A week later he was complaining that he had lost his relaxed complacency and no longer felt like playing golf or dallying the hours away as he previously had done.

If such results are any indication, it might be possible to build new worlds in the tropics—worlds where the enervating effects of climate would be overcome and where men would be active and vigorously creative in their own right. There are still vast untapped natural resources of men and raw materials, and such reserves are particularly important to-day. Vital supplies of rubber and quinine for malaria from the Dutch East Indies have been cut off by the Japanese invaders. There is quinine in Peru. Rather considerable sources of raw rubber exist in the steaming jungle of the upper Amazon basin. The natives however, are too sluggish, too enslaved by tropical climates, to care about collecting the raw materials, and fever-ridden swamps have so far daunted efforts at exploitation by white labour. We can only speculate as to whether a carefully organized programme of B vitamin dosages would overcome this unfortunate situation. But it might help solve our problems of shortages in rubber and other raw materials.

Furthermore, the task of winning a war demands a new output of energy which could conceivably be produced by the widespread application of new knowledge. Tropical fighting has played an important role in the war to date and will play an even more important part in the future. Soldiers defending United Nations outposts in Africa, the Orient, or in our own Caribbean bases will need special diets as well as proper sanitation facilities. Our numerous experiments and observations show that one item of particular dietary importance should be extra supplies of the B vitamins. This step might well enable soldiers to be as active in sizzling weather as they were in cooler surroundings back home. There can be no doubt that vitamins are as important as bullets when it comes to beating a determined foe.

As we have pointed out, the people of the United States who remain behind to supply material for the war machine need less of the B vitamins than do soldiers or natives in the tropics. In our more energizing climate it is no wonder that our children grow so rapidly and with an abundance of robust health, or that adults feel equal to the great wartime task before them. The one period of threat to our vitality comes with severe summer heat, and the resulting slump which so many Americans encounter in July and August can be largely prevented by taking extra B vitamins.

You also need an ample supply of the B vitamins in winter cold, of course, but a keener appetite usually sees that you get them. It is quite possible that better resistance to colds and other winter respiratory infections might be built up if there were more of these combustion catalysts present to keep the vitality of the white blood cells at a really top-notch level. For over twenty years I have accomplished this in my own family by reinforcing the dietary vitamin supply with the regular addition of a crude extract of alfalfa leaves—alfalfa being one of the richest known sources for most of the B vitamins. All those years I had been advocating use of the alfalfa extract only during the winter season. Now perhaps I should urge it also for summer heat.

We of the cooler regions of the earth have little reason to be proud or boastful of our more progressive spirit and record of accomplishment. Rather should we give humble thanks to a kind Providence for having placed us under such favourable climatic conditions and amid such an abundance of good food. May we use these natural blessings wisely!

CHAPTER 5

THE FALLACY OF EARLY TROPICAL MATURITY

ONE'S SURROUNDINGS DO CONSIDERABLY more than simply affect his diet and vitamin requirements. As we have already emphasized and shown in laboratory tests, environmental temperatures regulate the very growth-rate and vitality of all living things.

A good index to the devitalizing effect of hot climates is the age at which tropical dwellers mature, and our tests and observations in connection with this interesting problem have led us to contradict one of the most widely held misbeliefs in humanity's long record of popular fallacies. Ninety-nine out of a hundred persons are firmly convinced that maturity comes earlier in the tropics than elsewhere.

No matter where one is—among the Chinese or the Japanese or the people of Hawaii, in the jungles of Panama, or for that matter in the temperate regions of the United States—one finds it taken for granted that in hot countries the arrival of physical maturity is speeded up. Time after time, mothers living in the tropics have told me of sending their daughters out of the heat to prevent too early a beginning of sexual functions. Physicians in these areas are just as convinced as the laity. Yet my own observations and researches over a long period of years lead me to believe that the truth is quite otherwise. I realize that such a statement will be regarded with scepticism if not with incredulity. Let me set forth the evidence on which I base it.

Hilda and Ivan have shown us that growth-rate and speed of development are sharply retarded by continuous warmth. Sexual cycles begin definitely later in the heat, and the onset of fertility is still further delayed. In view of the common idea that the tropics hasten human development, this evidence interested me greatly, but nowhere could I find backing for the popular conception. The beginning of sexual functions can be quite sharply dated in girls and the event is usually remembered in a woman's life. Therefore it affords a basis for the collection of fairly reliable statistical information on this phase of body development. No such statistics, however, support the belief in early tropical maturity. All studies support the mute evidence of Hilda and Ivan.

Childhood growth proceeds most rapidly and the sexual functions develop earliest in people living in the coolness of middle temperate latitudes. The average age for onset of puberty in girls of the upper Mississippi basin is just slightly past the thirteenth birthday, while in many tropical lands it comes after the fourteenth birthday, and in regions of severe moist heat as late as the fifteenth and sixteenth. So mothers who send their daughters from tropical heat to temperate-zone coolness are defeating their own purposes.

In Panama my wife and I spent a few months collecting various kinds of statistics on the schoolchildren of the Canal Zone. I was particularly interested in Canal Zone people because there we have Americans who migrated from invigorating temperate climates to live in the tropics under conditions which are otherwise just as favourable as in the American communities from which they migrated. Proper sanitation has held tropical diseases to a low level and wholesale importation of food from the United States has kept the American migrants free from the undernutrition so commonly seen in natives living on tropically produced foods. We found the Zone-born American children smaller in stature and more retarded in development than those newly arriving from the north. And the youngsters coming down from the north, after living two years or more in the Zone, showed definite retardation which in some ways made them inferior even to those of Zone birth. Here we obtained perhaps the first definite evidence of the depressing effects of tropical heat upon people kept free from the other undermining factors usually encountered in such regions.

In Chapter II, the section devoted to Hilda and Ivan, we presented reasons for the adverse effect of the tropics. The human body is a combustion machine, burning food in the cells and aided by "no-knock tetra-ethyl lead" in the form of the B vitamins. But you are not as efficient as you may have believed yourself to be. Man himself has created a machine which can convert a greater percentage of its fuel energy into work output than can the human body. The Diesel engine is able to utilize as high as 37 per cent. of its fuel energy, while your body rates only 20 to 25 per cent. efficiency. That means you must eliminate from your body three or four times as much heat as you use in your living processes. And you must get rid of this waste heat quickly, for if it piles up in your tissues you will develop fever and die of heat stroke unless relief is obtained. You have an intricate and highly effective mechanism for getting rid of this heat from your skin surfaces for brief periods. If faced with difficulty in heat loss for two weeks or more, however, your body automatically reduces its rate of food burning so that there will be less heat produced. It is this lowering in combustion rate within your tissues which makes you live less actively, and makes your child grow more slowly, when faced with prolonged external heat.

Practically every phase of your vitality is dependent upon the energy you get from the burning of the food you eat, so any reduction in the rate of burning compels you to live on a lower level of vitality. That makes inevitably for retarded development and a less vital existence in tropical heat. On a scientific basis, therefore, there can be found no support for the belief in early tropical maturity. Then how did it arise and become so widely held in all countries of the earth?

I have approached the matter from the historical angle as well as from studies on animals and the use of present-day human statistics. Back through medical writings of recent centuries, and on through the Latin and early Greek sources, the belief in early tropical maturity found almost universal expression, but was never supported by factual evidence. All statistics published during recent centuries have shown earliest development taking place in the temperate zones, with retardation in either tropical heat or in polar cold. Even Hippocrates said that girls developed earlier in the warmer countries, although he recorded an onset of puberty at the average age of thirteen in girls of early Greece.

It would seem that this belief in early tropical maturity must have originated several thousand years ago, nearer the last ice age, when polar cold prevailed in present temperate regions and optimal conditions for man were to be found only in what are now tropical or subtropical lands. That the belief should have been handed down through the past two thousand years without factual basis makes it quite plausible that the origin of it goes back much farther still. It has not been so very many thousand years ago that the polar ice cap extended down to where I sit writing in Cincinnati.

Body development seems retarded just as much by benumbing cold as by tropical heat. Puberty comes on fully as late in Eskimo girls of Labrador or Greenland as in girls living in the depressing heat of tropical lowlands. Explorers and travellers have been misled by the retarded growth of Eskimo children, just as they were in thinking the stunted, child-like mothers in tropical lands had matured early. Some writers even went so far as to call the indoor climate of an Eskimo igloo tropical. It is true the igloo air temperatures are high, but they must be to overcome the rapid loss of radiant heat to the icy walls on all sides. Even what appears to be a heavy perspiration bathing the occupant's skin may well be largely moisture from the saturated air of the room condensing on any surface available.

Only in middle temperate regions is the human optimum reached and the earliest development attained. As earth temperatures have risen through the past century to ameliorate somewhat the polar cold, Eskimo puberty has tended to come on at earlier ages. Even with our laboratory animals, too much cooling retards growth and delays onset of the sex functions just as effectively as does too much warmth. All warm-blooded animals (including man) seem to do best when body heat is lost with neither too great ease nor too great difficulty. At present, the middle temperate regions seem to provide the happy mean for greatest vitality.

Our children in Ohio and similar latitudes are the ones who now grow most lustily and are fullest of bounding energy and vitality. After twenty years spent in trying to direct intelligently the energies of three growing youngsters in Cincinnati, I often find myself envying tropical and Oriental parents their more docile, better-behaved offspring. One must bear in mind, however, that positive lusty health is of necessity accompanied by an abundance of energy and that this excess energy usually makes the youngsters more assertive and parental discipline more difficult.

Attached to the fallacious belief in early tropical onset of sex functions is also a belief that motherhood is possible at earlier ages and fertility is highest among tropical people. This also I have found quite untrue. A few years ago, while collecting statistics on climatic effects in a large naval port of a tropical country, I was occupying a hotel room immediately overlooking the harbour and motor-launch landing. Each afternoon between four and six o'clock, scores of sailors in gleaming stiff white uniforms were brought ashore from the warships in the launches and hurried off the wharf toward the city. Between six and seven o'clock each morning I was awakened by the same motor launches taking back to the ships similar scores of white-clad figures wilted by a night of city diversion.

Then during the day I collected statistics on illegitimate first-births in the city's largest hospital. Although there was an almost unbelievable freedom of sex relations prevailing among the city's lower economic groups, I found a late age for the first childbirth. One young unmarried mother had been consorting for three years with a foreigner before giving birth to her first child, another with two native men and one foreigner, and so the stories went. The important point discovered, however, was that the age of the mothers at the time of giving birth to the first child was found to be the same whether they were married or single. Evidently this age represented the average beginning of real fertility in these women.

A similar late age at first childbirth was found among the Chinese at Hong Kong, where illegitimacy is rare and every effort is made to obtain children. Throughout regions of depressing tropical heat, the average age for mothers at the time of their first childbirth is about 19 years, regardless of whether or not they are married. Even in India, which has been depicted as the land of child-mothers, statistics record an average maternal age, at first birth, of between 18 and 19 years. So there seems to be little more than a very rare occurrence of motherhood among tropical children. Retarded growth and stunted form may give to many of the 17- and 18-year-old mothers a child-like figure as viewed by people from more invigorating climates where higher growth standards prevail. I experienced, for instance, a tendency to underguess the ages of native tropical children by about three years until I had grown accustomed to the general undernutrition so prevalent there.

It is among girls of the earth's more stimulating climates that child-mothers could be found in abundance if the tropical freedom of sex relations were not inhibited by a more rigid moral code. Illegitimate first-births in Cincinnati come at an average maternal age of 15 years instead of at 19, as found in the tropics. The earliest recorded age for motherhood (with living offspring) is that of a five-year-old girl in Lima. Although this happened within tropical latitudes, it took place in a city where temperatures are kept favourable throughout the year by the cool Humboldt Current flowing northward from Antartic regions.

During a visit among the natives in the rice-terrace region of northern Luzon (in the Philippines) I learned that relations between the two sexes were entirely uncurbed through adolescence and youth. A keen, American-trained native Bontoc physician gave me a good description of such affairs among his people. The parents keep their youngest child in the main hut with them, but all older children sleep out in a so-called dormitory, which looks like an overgrown doghouse. Here the children and youths from different families may mix as freely as they wish without any parental supervision whatever. When the form of a girl fills out, nearing the physical development which indicates to her people the close approach of reproductive capacity, she is properly married off. Illegitimacy is rare and is much frowned upon, even though adolescent sex relations receive no attention whatever.

One American schoolteacher with a high moral sense had attempted to correct the dormitory situation just before I arrived, insisting that the sexes should be housed separately. The result was a walk-out strike of all her pupils which was still in progress when I arrived. Neither side was yet ready to consider opening negotiations and the prospects were that the American moral code would have to be abandoned before the school could resume its sessions. The natives there have tilled those magnificently terraced mountain-side rice fields for many more centuries than American history covers, and their living customs have become just as firmly planted as are the rice fields themselves. Great engineering skill has been used in carrying water for miles through bamboo troughs from one hillside paddy to another; and one may say that they developed the same efficient realism in their social relations.

Proper use of the long period of adolescent sterility, as practised in many of the islands of the East Indies and South Seas, is likely to lead to well-fitted matings for later life. Here again the native customs seem appropriate.

Whenever I speak on the tropical depression of fertility, some listener always bring up the point that tropical birth rates are everywhere much higher than those of temperate regions. And so they are—not because of a greater ability to reproduce, but because lack of inhibitions allows every trace of fertility to yield results. Temperate-zone races could far out-breed those of the tropics if they consorted with the same lack of restraint. This can be clearly shown on laboratory animals kept under conditions of tropical warmth and temperate coolness. They mate with equal freedom and zest in both environments, but conceptions are difficult to achieve in the heat, while in the cold almost every mating results in a large litter of lusty young.

Climatic differences in human restraint often result in surprising situations. High-pressure Northerners going from midwinter cold down into the relaxing warmth of southern Florida or the Caribbean region often find themselves face to face with a sharp let-down in their moral code. Fuel is added to this fire by the laxity of sex relations so common in the native people about them. Many a person has behaved under such conditions in a way which seems most surprising after a return to the North has stiffened up the inhibitions. The "thou shalt nots" of Christianity are certainly appropriate for the energetic people of cool climates where vitality runs high and submission to every impulse would bring chaos.

The worst social evils of world migrations have often been associated with those climatic differences in emotional restraint. Large numbers of north-Europeans who migrated to the stimulating climate of northern United States fitted in well with life in the new land because its tempo was not so different from that of their former home; but migrants from warmer regions found themselves in great difficulty under the increased stimulation of our invigorating climate. They suffered a marked increase in bodily energy and desire for activity long before they had developed the moral restraint necessary for harmonious existence at high energy levels. Mexicans migrating northward, Negroes coming up to work in our industrial cities, Europeans from the warmer Mediterranean countries—those were the groups who found themselves in greatest conflict with American moral codes for a generation or two after migration.

On the other hand, I have seen many women who have migrated to the tropics suffer a real breakdown because they were unable to throw off their restrained code of northern life and lead the more relaxed existence which seems necessary with the lower energy level there prevailing. Women are more affected than men in such migration.

The depressing effects of tropical heat on fertility appear in still another way. Even in temperate regions there may be as much as a 50 per cent. fall in conception rate during severe summer warmth. Such was the case in Kansas City and in other areas afflicted with the prolonged severe heat wave of the 1934 summer. Each year, Florida shows a 35 per cent. reduction during her summer warmth. Accompanying this hot-weather fall in fertility are frequent menstrual difficulties—cessation of the monthly periods, painful cramps, or the secondary effects of an upset endocrine system which make life miserable for the person involved.

Our studies of man in hot weather and tropical climates show that he is no lord of creation, but rather a pawn of his climatic habitat. His activities and vitality shrivel in depressing warmth, and the difficulty of body-heat loss shows most strikingly in his ability to reproduce. Fertility declines sharply in the heat and rises to a peak in optimal coolness. This is just as true with the seasonal change from hot to cold as it is with climatic differences between temperate and torrid regions; and it probably holds also for those slow changes in earth temperatures which cover many centuries. For almost a hundred years now, earth temperatures have been rising; is this to bring a reduction in racial reproductivity and an easing of population pressure? Perhaps further insight into the dynamics of life will one day answer that question, but we cannot wait for the answer. The chapters to come will take a closer view of ourselves, the people of cool climates, who are always too busy to wait.

PART II

CHAPTER 6

THE PRICE OF ACTIVITY

TEMPERATE-ZONE NATIONS ARE LEADERS in world affairs. Their peoples, activated by cool climates, have had the energy to build great power plants, skyscrapers, dams, bridges, and a legion of impressive monuments to human initiative. They visit the tropics mainly for trade and war, and have long benefited from tropical raw material wealth which the natives were too sluggish to exploit. But it does not follow that we of the earth's favoured regions are less under the control of great outside forces. While slow-maturing people in hot climates have difficulty losing body heat, our ready ability to get rid of it is a mixed blessing, since it drives us on to such activity that our bodies often suffer as a result. A life full of activity and stress is temperate-zone man's unconscious response to climatic urging; he himself has little choice in the matter.

It is this stress which is bringing the most alarming health menaces to people of the earth's middle latitudes. The body seems unable to endure the severe strain thrown upon it by a constantly increasing pace of activity. Longstanding lack of proper rest and relaxation tends to leave the system broken and prematurely old. Even the best of machines must be idle at times for renovation and repair of worn parts if complete breakdown and early discard are to be avoided. It is in those human body parts most intimately concerned with supplying the tissue fires that evidences of breakdown are most frequent.

Oxygen must be carried from lungs to body cells, and it is the circulatory system (heart and blood vessels) which eventually suffers most from prolonged forced draft in the human firebox. The red cells of the blood are the real carriers of the oxygen. In those same regions where heart failure is most common we find also most frequent exhaustion of the bone marrow which produces the red cells. This exhaustion is known as pernicious anæmia, a disease rare in the tropics, but quite severe in middle temperate regions. Another disease also most prevalent in the stimulating latitudes is diabetes. It represents a breakdown in the body's ability to transform the food eaten into the special kind of sugar which can be burned in the cells.

Proper ease of body heat loss, as made possible by an invigorating climate, thus works upon man by stimulating his internal combustion in much the same way a forced-air draught speeds up the burning of fuel in a steam engine. Stimulated combustion and a liberal release of energy then drive him into ever-expanding activities, throwing more and more stress on the body parts which supply oxygen to the tissues. Every good engineer knows the capacity of his engine, but people seem unable to estimate properly their own limits. Although they may not be able to avoid all dangers, a proper appreciation of the value of rest and relaxation would reduce the risks. Ignorance of these safety rules results in other forms of breakdown besides pernicious anæmia and diabetes.

Within the past two years, six of my colleagues on the Medical College staff have died of coronary disease and sudden heart failure—and only one of them was more than fifty-two years old! Several others have suffered heart attacks, but still survive with restricted activity. The rest of us up near the half-century mark are beginning to fear this menace which is striking down the most active of our members while still in their prime of usefulness. Heart failure to-day easily leads among the causes of death in the northern United States. In 1940, two-thirds of the deaths among American physicians were recorded as due to failure in the heart or blood-vessel system! The only near competitor here in the north is cancer. In the tropics the picture is quite different, for coronary trouble and heart failure are rare there except in advanced old age.

Additional emphasis was given to the problem of coronary disease by an editorial in the April 11th (1942) issue of the *Journal of the American Medical Association*:

> Physicians always advise their patients how to live longer and better; they themselves often die prematurely of preventable or at least postponable causes. The prevalence of deaths from heart disease, particularly coronary disease, among physicians at relatively early ages has in recent years increased sharply. Coronary disease has come to be known among physicians as "doctor's disease." . . . A new development is the Committee of Longevity, Class of 1900, College of Physicians and Surgeons, New York, which has organized for the purpose of prolonging the lives and improving the

> health of one hundred surviving members of the class, which originally numbered one hundred and seventy-five graduates. Already the idea has received much publicity through editorial comments in New York papers. Superficially amusing, but basically significant, is this comment from an editorial in the New York *Sun* (July 9, 1941): "Laymen whom middle age prompts to think of such things are bound to be interested in the work of the Longevity Committee. . . . These doctors should be able, if anybody can, to propagate the art of collective good health. Laymen will note with an understanding smile, however, . . . that a good many doctors have this much in common with a good many laymen: they neglect their periodic examinations or delay in taking treatment."

Medical men are much worried about the presence of this killer among them—a killer which spares the weak and infirm, but strikes down instead the most energetic and progressive members of the race. Hardening of the arteries, high blood pressure, coronary disease, apoplexy—these are the blood-vessel troubles which incapacitate and kill an astonishing number of people in the stimulating middle temperate latitudes of America. Hardening or sclerosis in the vessel walls, often with patchy roughening of the lining, is the tissue change found at autopsy, but no one knows yet just what factors of life bring it on. Only in the last few years have medical scientists been able to reproduce and then relieve these conditions in laboratory animals. Two decades ago the hardening process in the vessels seemed to take a slower course and resulted more often than to-day in kidney failure. Rupture of a hardened artery in the brain—apoplexy or stroke—is about as common as formerly. But the sclerotic disease now seems to affect the coronary arteries supplying blood to the heart muscle itself much earlier in life and with much greater frequency than in former decades.

An engineer in his early forties, director of research in a large corporation, developed high blood pressure, spent a year and a half trying to get it back under control, and is to-day assigned to a minor post of lesser stress—practically finished with life before he is fifty. A younger human dynamo has just taken his place in the ceaseless, pushing struggle which characterizes American business. He too seems destined for the same end. Keen competition and continuous pressure for results allow him no rest during the day and keep him keyed up to such a pitch that he cannot relax properly at night. One of my patients who will soon migrate to southern California for sinus trouble is of this same dynamic type. He is already afflicted with hypertension and coronary trouble before forty-five years of age. One of the most energetic of my medical colleagues developed a rapidly progressive hardening of the arteries and died of heart failure at fifty. And so it goes, with business executives and professional men the choice victims of this ruthless enemy.

All this has a very direct and personal interest for me, because only by careful watch over my winter activities have I succeeded in keeping sclerosis and high blood pressure at bay. I spent my childhood and early youth on a farm near Kokomo, Indiana, where climate acts as a dynamic force on life, and frequent weather change is a most disturbing influence over the daily functioning of the body. I had numerous colds and attacks of sore throat during Indiana winters, and my heart is now quite sensitive to stress or too much stimulation. No actual rheumatic heart disease can be found, but the repeated throat infections probably left some mark on my heart muscle. Palpitation occurs readily after even moderate smoking or coffee drinking. In addition, my inner dynamo seems geared for a fast pace of action. It speeds up through winter cold and slows down in summer warmth. With the winter acceleration comes a rise in blood pressure and an inability to relax which several times in the last twenty years has become really troublesome. Summer heat brings me a welcome relief from this cold-weather stress, with the blood pressure settling back to its proper level.

Although I may have particularly good reason to be interested in weather stresses at present, my study of such matters actually dates back to my senior year at the University of South Dakota in 1917. My first bit of research dealt with the effects of high and low temperatures on the thyroid gland in rabbits. A box fitted with electric lights served as a hot room, and the outdoor Dakota winter supplied ample cold. My wife was pressed into evening service as anæsthetist while I snipped out small bits of the rabbit thyroids for microscopic study. We had been married at the end of our second year in college and were both busy with regular studies during the day, so these outside experiments were relegated to evening hours. The next year they were continued at the University of Kansas, where I went as an instructor in physiology.

That first piece of work showed the marked stimulating effect of cold and the quieting influence of warmth upon body functions. These findings have been expanded and given added emphasis by later studies. Through the subsequent ten years at the University of Cincinnati, studies on blood clotting and the control of hæmorrhage absorbed my energies, and it was not until the Rockefeller Foundation engaged me at the Peking Union Medical College in North China that I developed a deep interest in climate as a major factor in human affairs. I had been borrowed by the foundation from the University of Cincinnati to work at the college and help introduce Western medical practice into China. There I encountered my first personal experience with really debilitating warmth as the Little Heat, Middle Heat, and Great Heat of Chinese legend piled one on top of another to make the summer of 1927 a rather terrifying time.

Our younger son was born during the Great Heat of that summer. The fight I made to overcome its effects upon him helped greatly in opening my eyes to the importance of climate as a physiological factor in life. For five years it was a nip-and-tuck battle for his survival, and to-day both he and his mother bear as "scars" of that experience a troublesome sensitivity to summer heat. It was during that summer that I began to see how prolonged heat might cause the body to slow down its activities and result in a fall in blood pressure, a drop in internal combustion rate, and a more sluggish pace of living.

My son's experiences, however, were not all that emphasized the importance of such problems to me. The significance of outside forces was brought home by contrast to my own childhood. After my farm life near Kokomo I went to South Dakota with my parents at the age of seventeen to take up residence under climatic conditions even more invigorating than those of Indiana.

It was this sort of childhood and youth, brimming over with energy and activity, which later made a fascinating contrast to the severe effects of the prolonged heat in Peking. The tropical lethargy and sluggish life encountered in India, the Malay states, and South China on the way to Peking impressed me. It was so utterly different from the active existence to which I had been accustomed in temperate-zone coolness. As a child I always had a particularly strong urge to find out why things happened as they did. Now I began a really scientific search for the why of climatic effects.

In China I became my own first guinea-pig, although the heat affected me less than it did my son. I had spent a most active winter and spring teaching and doing research after arriving at Peking late in September of 1926. All was well until near the end of the next July, when both investigators and laboratory animals wilted in the severe heat of the Oriental monsoon season. Tropical lassitude captured me then for the first time in my life. I neither did nor wanted to do anything through August and early September, but felt certain that another good year of work would follow such a complete rest. October came and went without any urge to work. I took care of teaching and routine hospital duties, but that top-notch feeling so necessary for first-rate investigative work was still absent. Thanksgiving passed and the Christmas holidays came—still with nothing accomplished. In May families of the foreign professors were evacuated as the revolutionary forces from Canton neared Peking, but still I had felt no real urge to work.

Something over which I had no control was slowing down my accustomed pace of life. Fortunately I had the academic background to tackle the problem. My first medical faculty post had been in physiology and I later taught biochemistry and medicine. The physiological viewpoint, however, dominated my twenty years of research. It was particularly applicable to climatic studies. In Cincinnati I had worked with diabetic patients and the high blood pressure and heart failure cases which filled the hospital wards. Consequently, I naturally became interested in the lack of these diseases among the Chinese people of Peking at a latitude even slightly farther north than that of Cincinnati.

Why was there less evidence of stress-caused illness among the Chinese people? The search broadened year by year after my return to Cincinnati, and before long it began to yield an insight into the factors at work. A fairly clear picture has finally been obtained of climatic dominance over man, one which explains why he is pushed forward impetuously in certain regions and held back to sluggish pace in others.

It seemed to me that in climate lay one of the basic reasons why the Chinese people have been so passive in accepting the domination of more energetic races. The weakening effect of their severe summer heat is not counterbalanced by vigorous winter weather such as we have in the northern United States. Sudden weather changes are much less common than in America because of a lower level of cyclonic storminess, and autumn coolness in Peking approaches almost unnoticed. Once the ground is frozen, it seldom thaws out until spring. People keep the even tenor of their ways throughout the year, adding more padded gowns for each few degrees the temperature falls through autumn and winter, and gradually disrobing again during the spring rise. The winters are not disturbed by sudden warm spells or the summers by days of refreshing coolness.

This difference in storminess between Peking and Cincinnati is perhaps largely responsible for the marked difference in vigour between the people of the two regions. The blood pressure of Americans usually falls during a few years' stay in Peking, and that of Chinese rises when they come to the northern United States, even without any definite change in dietary or living habits. Two of my Peking faculty colleagues, both native Britishers, experienced a 30 per cent. fall in pressure within a year after returning to China from furloughs spent in England or the United States. In Peking it was difficult to find enough cases of hypertension—high blood pressure—for teaching purposes, while in Cincinnati almost a third of our hospital beds are occupied by this type of patient.

Regions with tropical climates, as well as those with relatively little storminess, have a relaxing influence on the body and a lowering effect on the blood pressure. In 1935 I was sent to the Philippines by the Leonard Wood Memorial for the Eradication of Leprosy, now the American Leprosy Foundation, to study the possible relationship between climatic stimulation and leprosy. The results of this study will appear in a later chapter; our immediate concern is with blood pressure. A blizzard was raging behind me as the ship left New York in late January, and I watched my blood pressure drop from 140 systolic and 90 diastolic down to truly subnormal levels in the Philippine heat.

The ship was a 13-knot freighter. As we travelled down through the soothing Caribbean warmth and up the western coast of Central America and Mexico, I could feel my inner machine slow down and the restless urge for action gradually abate. Soon I was able to sit relaxed for hours on the deck, freed from the feeling that I should be doing or planning some new activity. Tropical lethargy is indeed a pleasant state when it has finally and completely enveloped one. I can readily see why its victims would resent being dragged from its dreamy embrace. By the time I had been in the Philippines a few weeks, my blood pressure was down to 88 systolic and 60 diastolic (the normal is 120 systolic and 80 diastolic). It rose slightly after my return to Cincinnati in May, but not until late the next winter did it again hit the 130 level.

In Manila I was surprised to find more cases of hypertension than would be expected in the hospitals of a tropical city, although the number was much less than would occur in an American city of the same size. The probable reason for this strange situation seemed again to lie in storm effects, for Manila lies in the westward path of the Oriental typhoons which sweep across the Philippines and lash up along the China coast. Although high blood pressure is generally rare in tropical climates, the storminess seems to affect people, to increase the stress of life and the incidence of the disease. In Manila the net effect of these two opposing factors resulted in a hypertension rate above that normally to be found in tropical centres.

Another sign of a similar interplay of forces was obtained last year by a young physician in the Canal Zone. Thousands of labourers are imported from the West Indies for work in the Zone and thousands of native Panamanians are also used. All must be carefully examined before being hired. The examinations revealed that hypertension was far more common among the labourers from the West Indies than among the natives of Panama. Like the natives of Manila, the West Indians were much less afflicted than people of the United States, but they showed more high blood pressure than is common among tropical races. Again, the only evident difference is that the West Indies lie in a tropical storm pathway where hurricanes are frequent, while in Panama cyclonic storms are almost unknown. The matter needs careful investigation under controlled laboratory conditions and I hope soon to attack it.

During the weeks spent in the Philippine heat—in the typhoon-free season—I developed a real enjoyment of relaxed idleness. Nothing like this had ever been possible in Cincinnati, even during summer warmth, for depressing heat here is seldom long continued without being interrupted by periods of refreshing coolness. The heat during the summer of 1934 in America was the most severe and prolonged of any year within my memory. That summer I noticed many of us changing to a tropical metabolic make-up; our tissue fires and blood pressures subsided to tropical levels.

One sixty-year-old patient with extremely high blood pressure and severe distress, whom I had been seeing through 1933 and the spring of 1934, benefited markedly by the prolonged heat. His pressure declined and he was quite comfortable, with only a modest hypertension, when he last visited me four years later. Every summer brings a moderate fall in the blood pressure of many people, but it takes a long heat wave to exert any pronounced effect. We have learned, however, that people with diabetes or limited working capacity of the heart can regularly allow themselves more freedom in summer warmth without ill effect.

Few people realize that they expend more energy climbing a flight of stairs in January than in August, or that the tropical native can do more work than the energetic northerner on a loaf of bread as fuel. He will take a longer time for the job, but as a working machine he is more efficient; he wastes less energy in maintaining high muscle tone and in useless motions. Not only are people of middle temperate regions pushed into doing more because of a rapid tissue combustion, but they are also more wasteful in the doing of it. These two factors combined are perhaps largely responsible for the alarming evidences of bodily and mental breakdown they are now showing.

The rush of city life in itself seems to intensify the stress factors of life, especially in regions where climatic stimulation is intense. High blood pressure, hardening of the arteries, heart failure, diabetes, and all the other evidences of stress are much more common in the city than in the country. Statistics show that this applies even to cities of five to ten thousand population, but probably not to village life. It is important to discover just what factors of city life are responsible for the appalling evidences of bodily and mental breakdown which urban populations of America are undergoing. Your country cousins may appear unsophisticated, but they live a much saner life and are likely to remain active long after you have broken under the strain.

Men are far more involved than women in this breakdown, particularly with the acute types of heart failure—coronary attacks and angina pectoris. The worries and effort entailed in supporting a family are probably responsible for the greater evidences of stress in men, because breakdown in women is also accelerating as they too become wage-earners in the commerce and industry of cities. Diabetes is now more frequent in women past forty years of age than it is in men, and hardening of the arteries is rapidly increasing. Stress in women, however, shows most frequently in the form of nervous breakdown or exhaustion. Lack of restful hours in the rush of city life is taking this toll in the health of both sexes. The effects are less evident during the early decades of high vitality, but after forty the human machine begins to show its age. Men in their forties are usually hardest pushed in their efforts to get ahead, while women of the same age group or a bit older must face disturbing physical and mental readjustments incident to the "change of life."

When knocks and creaks begin to appear in our bodies, it means that we need longer and more frequent rest periods so that repair forces can do their work. Proper hours of sleep at night are essential, but a short afternoon nap is equally important. Few American men take time out for such relaxation however much they might benefit by it. Not only do they miss this rest and reach home thoroughly fatigued by the day's stress, but they are then often called upon to go through an evening of social activities with a wife who has been refreshed by her afternoon nap.

It is probably this lack of rest and relaxation, accumulating through years of urban existence, which is behind much of the breakdown taking place in the earth's most energizing areas. The northern United States leads the world in this respect, for nowhere else is the climate quite as driving in its effects or as upsetting with its frequent storm changes. People of this region need more rest instead of less, but their energy and restlessness keep pushing them on at a rapid pace until the collapse comes.

In tropical lands the afternoon siesta is an established custom, even for most city dwellers. Women migrating from energizing climates need it, for they are prone to nervous exhaustion if they try to lead their life of accustomed activity in tropical heat. One of my medical friends from the Ohio Valley belongs to the type which succumb in a short time from some form of stress breakdown if they remain in this stimulating climate. He left the north early, however, and has spent several active and useful decades in the tropics. He is now in his sixties, alert and healthy—and an afternoon siesta and proper hours of sleep at night are essential features of his daily routine. Each year he spends a few months in the northern United States, and his greatest complaint is the difficulty of obtaining sufficient rest.

One of the most refreshing features of a tropical visit for me is the relaxing afternoon nap, taken in the thoroughly disrobed tropical fashion. I always come back from a few weeks of such relaxation well fortified for another year of northern stress. Summers in Cincinnati are almost as restful, for then I usually take luncheon at home and sleep for half an hour or so afterwards. During the winter the stronger urge to be doing something keeps me on the go from early morning until evening and leaves me thoroughly exhausted by the end of the day. Temperate-zone summers should be periods of real biological rest for people who are hard pushed through the cooler seasons. I myself find the winter stress much more trying if I avoid the summer heat by migrating to cooler regions. A summer spent at Woods Hole (on Cape Cod) is certainly delightful, but it leaves me less fit for the next winter's activities than does a summer spent in Cincinnati heat.

There are probably few factors which would change the alarming urban breakdown picture as markedly as the institution of a regular afternoon siesta and of adequate sleep at night. The matter is an extremely important one for people entering middle life, when the body machinery is beginning to show signs of wear from previous decades of activity. Unless present trends are in some way reversed, civilization in the earth's most progressive regions will be truly threatened by this loss of its most energetic and promising members just as they reach what should be their most productive period. A man at fifty has gained valuable experiences which increase his value to society from then on to old age. It is more important that his life be spared for another decade or two than that a few more babies be saved from the hazards of infancy and early childhood. Medical science is faced with a serious need for better methods of handling the health problems of middle and more advanced ages.

The basic need is that men learn the art of living a hygienic life. Once disease actually appears, particularly that of the breakdown type, it is often too late to repair the damage. This is almost as true of nervous breakdown as it is of heart failure, for in either case the stricken individual remains crippled for life. It is difficult to get people to see this, however, until they themselves have suffered—and then the time for healing has passed.

Americans in the prime of life often say they prefer a fast pace and a merry one, come what may at a later age. But life assumes an entirely different aspect once the break has come and they are faced with the necessity of living on under sharply restricted conditions. As a result, they advise the younger generation to take life less strenuously, but young folks pay little attention. Their exuberant energy pushes them on in the never ending rush and hurry, and the destructive round of work, unalleviated by true relaxation, continues. We are becoming all too familiar with the results.

CHAPTER 7

DRUGS AND STIMULANTS

EATING AND DRINKING HABITS often greatly accentuate the effects of climatic environment. In the tropics people need extra supplies of the B vitamins, yet they eat meats low in these dietary factors and cook them so long that even the reduced content of valuable ingredients is destroyed. The net effect is to further emphasize the lethargic pace characteristic of hot climates. An opposite but equally unfortunate set of circumstances exists in energizing temperate-zone climates, where men are driven to restless activity in their daily lives, yet turn too frequently to drugs and stimulants which place a further burden on their straining bodies.

Caffeine—the stimulating factor in coffee, tea, and cola products—provides an excellent example of this sort of habit. It is the ideal stimulant for the body tissues when properly used but its abuse probably constitutes the most widespread drug addiction among mankind to-day. Any regular devotee who develops a headache when the drug is omitted for one day should consider himself in that class—a private in one of the largest armies on earth.

Caffeine speeds up the burning of food in the tissues and increases their functional activities. Mental processes become keener, the heart works harder, reflexes are quickened, special senses become more acute, and in every way the body becomes more highly alive and vital. All this happens, however, only if the tissue response has not been dulled by habitual and often-repeated use of the drug. Being such an active stimulant, its continued use tends to bring on an exhaustion calling for ever increasing dosage.

Although originated and produced in tropical lands, coffee is consumed principally by people of the temperate zones. Well over half the entire world output is used in the United States—more than 2,000,000,000 pounds a year or probably an average of almost a pound each week for those who use it. Heaviest consumption is in the northern states.

Most users freely admit that they drink coffee for the pick-up and feeling of increased strength it gives. They like its help in carrying them through the day's stress, and probably for this reason it is used most heavily by people of the stimulating climates. For persons already subjected to the strain of a too rapid pace of life it does provide a transitory sense of fitness and efficiency. But its habitual use only intensifies the underlying exhaustion of body tissues which is to-day leading people of the invigorating regions into a most alarming breakdown.

Among ship's captains coffee is almost an occupational necessity. While *en route* to the Philippines in 1935 as the only passenger on a cargo ship, I was urged by the captain to try a sample cup of special coffee they had just taken on at Honolulu. He praised it highly as being able to keep him awake when no ordinary coffee would and used it for periods of protracted stress at sea when he had to remain on the bridge without sleep for days at a time. I am not a regular user of caffeine and am quite sensitive to its stimulating effects. So I managed to resist his urgings for a few days. But he finally sent the steward with a cup, catching me while I was playing chess with the chief engineer. As the captain said, it was really delicious coffee, and enabled me to go ahead and win three straight games. I had not the slightest urge to retire that night, however, even though I had nothing else to do except read the rather limited material at hand. The second night I went to bed, but was unable to sleep. The third I dozed off for a couple of hours, but it was not until the fifth night that I managed to get as much as six hours of sleep! After that experience I could appreciate why the ship's officers preferred to have this brand of coffee available in times of emergency when they had to keep awake. It naturally affected them less than it did me because they were all regular users of caffeine, but even so they used this brand only on special occasions.

The captain himself regularly drank about twenty cups of coffee daily, as nearly as I could estimate. Since such heavy coffee use is customary with those responsible for a ship's safety at sea, I can readily see why they so often come to an early end by sudden heart failure or apoplexy. Since then I have found much heavier users of coffee, and among people without such responsibility or special need for wakefulness to justify their over-indulgence. One extremely nervous woman claimed that she was drinking about 60 cups daily, her son about 30, and a grandson 15, the three of them using over a pound of coffee each day. Another woman, complaining of great nervousness, sleeplessness, headache, palpitation, and weakness, was herself using 3 pounds a week!

Such extremes, of course, are a form of slow if not very subtle suicide, especially in northern climates. But tropical natives may use caffeine with little danger of ill effects since their capacity for response to its stimulating action is low. Even I can use it almost regularly after being calmed down by a month of tropical heat. With the higher combustion rate of northern winters, however, I find it entirely too dynamic for continued use. These pages are being written under caffeine influence, for it does induce a clarity of thought seldom achieved otherwise. But even my single early morning cup must be discontinued after a week or so if troublesome nervous tension is to be avoided.

Coffee and caffeine are being used interchangeably because coffee provides by far the major part of man's supply of this drug. About four times more coffee than tea is used throughout the world, but in America the ratio is more like twenty to one. Orientals—particularly Chinese and Japanese—are heavy tea users, while in Europe the two are more evenly balanced. Tea leaves contain roughly twice as much caffeine (or simliarly acting substances) as does coffee, but methods of brewing the two beverages are so varied that either may contain more stimulant per cup as consumed. Americans are noted for brewing coffee of pleasant taste and powerful stimulating effect. Curiously enough, it is in the invigorating climate of the northern states that this art of brewing has been most highly developed.

Cola nuts form an important caffeine source for tropical natives, and their extracts are used in many popular cold drinks. Hundreds of thousands of Americans obtain considerable caffeine in consuming enormous quantities of these beverages. The demand is particularly strong among children and young folks who use little tea or coffee. It has been said that 5,000,000 pounds of pure caffeine go into the cold drinks manufactured each year, making some of them almost as potent stimulants as coffee. It is heartening, however, to learn that the manufacturers of one of the leading American bottled beverages have progressively reduced the caffeine content until now it is only a half-grain per bottle—as compared to the three grains or so in a cup of coffee.

Caffeine merits detailed attention because it is intimately related to climatic drive all over the earth and to the human stress which is becoming so devastating in regions where this stimulation is most intense. Although caffeine is valuable for brief periods of need, its over-use to whip up the flagging spirits of people already jaded by over-intense stimulation is a most irrational procedure. Not only does the drug—by masking underlying fatigue—permit people to perform more daily work than their systems can stand, but it often cuts down one's valuable sleeping hours. Contrary to common belief, the effect does not wear off entirely within two or three hours. The nervous system remains over-excitable for many hours, upsetting the relaxation necessary for a good night's sleep. This deadly combination of overwork and lack of rest gradually leads to physical or mental breakdown.

Although most physicians themselves like their cup of coffee, more and more of them are coming to see it as one important factor responsible for the increasing frequency with which heart failure is striking down members of their profession. Thoughtful medical men now recognize that caffeine throws added work upon the heart to support the greater bodily activity which it makes possible, and that use of the drug should be prohibited when the heart's working capacity is in any way impaired. There is also some evidence that it causes contraction of the vessels and a rise in blood pressure. In many cases of hypertension elimination of caffeine from the diet results in a considerable fall in blood pressure—unless advanced hardening of the vessels has already taken place. At the first hint of coronary trouble the wise physician now prohibits the use of all caffeine-containing beverages.

Some weeks ago a woman neighbour complained of being easily fatigued. She had pain in her shoulders and was nervous and weak. A local physician merely diagnosed her condition as high blood pressure and advised the woman to have all her teeth pulled. The price he quoted for the extractions and the fact that all his patients had been discussing such loss of teeth aroused her suspicions. Thinking that he might be one of those who profit by this overworked tooth-pulling idea, she asked my advice. I suggested consulting at least one other reputable physician or dentist before giving up all her teeth, adding that meanwhile she should give up coffee and see if that would not relieve the high blood pressure and most of her symptoms. This suggestion took her quite by surprise, since the first physician had not brought up the subject. She and her husband were rather heavy coffee-drinkers, and their children often drank cola beverages. After a few weeks, however, she reported her condition much improved.

Two other women about forty years of age also came to me with similar complaints a year ago; both obtained complete relief from their high blood pressure and the resulting symptoms by cutting out caffeine entirely. Another woman of the neighbourhood ploughed her way straight to a severe nervous breakdown with a coffee cup in one hand and an aspirin bottle in the other—but her physician never suggested that she avoid caffeine. A cautious hint finally caused her to try caffeine-free coffee, but the damage to her nervous system can never be completely repaired. It is an old and often heartbreaking story to see the devastation wrought by this delightful beverage among energetic northerners and the frequency with which doctors overlook this factor.

Just recently a mother brought her fourteen-year-old son for examination and asked me to find the reason for his retarded development and poor school record. He was a very nervous boy, undersized and malnourished, but without symptoms of any disease to account for his condition. His heart action was rapid and extremely forceful, however, and upon inquiry I found he regularly drank coffee for breakfast and usually had caffeine in some form at least twice a day. He was of German stock and had been started on the drug as a baby, actually being given a mixture of half coffee and half milk in his bottle. This seems to be rather a common practice among many Cincinnati people.

Several times in Boy Scout work I have listened to a number of hearts in sucession and been able to pick out the boys who were under the influence of caffeine at the time of examination. Children are particularly susceptible to its effects. A careful survey of several hundred school children a few years ago revealed that those who used caffeine regularly in any form were considerably retarded in development as compared with other children of similar economic level. I explained all this to the mother of my fourteen-year-old patient and finally obtained her somewhat reluctant co-operation in getting the boy to abstain from all caffeine-containing beverages. Two months later she reported that he was sleeping more soundly, progressing well in his studies, and was much more manageable at home.

Such experiences with the effects of caffeine on children have been repeated many times each year. They have finally led me to condemn most emphatically its use in childhood or early youth. Even during college years, when the days are too short for crowding activities, caffeine usage is very likely to be overdone. It adds temporary sparkle and vivacity to the individual, but is likely to reduce efficiency in the long run. The practice of taking coffee to study late the night before examinations is particularly bad. A much wiser procedure is to get plenty of sleep beforehand and then take stimulating caffeine about an hour before examination time.

It is encouraging to note the increasing use of caffeine-free coffee. Many thoughtful hostesses keep it on hand and inquire regarding the guests' preference. Some serve it instead of regular coffee without comment, but this shows little consideration for certain people, who will most certainly develop a headache without their regular caffeine. Particularly heartening also is the fact that most college students drink milk in their cafeterias and dining halls, although tea and coffee are available.

From the climatic standpoint, over-use of caffeine is a most dangerous and pernicious habit, since it usually developes in those very regions where people are already driven at too fast a pace by the urgings of climate itself. Wide individual variations exist in people's response to the drug, so that no one should consider three cups of coffee safe simply because he knows others who drink that much with apparent impunity. People of the northern United States should develop far greater moderation in caffeine usage and realize its close relation to the other stress factors which are bringing so many to a premature end.

To introduce the discussion of another popular drug, nicotine, I can think of no better anecdote than the following from the *Progressive Farmer*: Aunt Becky was punctuating the Negro preacher's sermon with "Amen! Amen! . . . Praise de Lawd! . . ." as he lit into every sort of sin from murder to shooting craps. Then the parson moved on against snuff-dipping, and Aunt Becky exclaimed to her neighbour indignantly, "Dar now! He's done stopped preachin' and gone to meddlin'!"

Many patients assume a similar attitude when their family physician gently suggests that they stop smoking, but the advice is usually sound. Though evidence is still far from satisfactory or complete, indications are that in many people smoking induces a blood vessel spasm or contraction which interferes with proper functioning of the vascular system. Such a spasm has been shown quite clearly for at least certain parts of the system. And thus, though physicians in general are heavy smokers, they have become somewhat more wary in the last few years. The astounding increase in coronary heart trouble is making them more suspicious of any factor which may accentuate vascular troubles. The use of tobacco—as well as caffeine —is now strictly prohibited at the first sign of serious coronary trouble.

The way several heavy smokers among my associates suddenly became total abstainers in recent months would have been amusing if it had not been so closely associated with the tragic faculty deaths. The most confirmed smokers, who previously refused to believe that tobacco was in any way harmful, now stopped smoking entirely.

One of my colleagues who died two years ago of coronary heart trouble had been a confirmed "chain" smoker for many years, lighting one cigarette from the burning stub of the preceding one. After his first coronary attack he quit both coffee and tobacco for almost two years. Habit finally reasserted itself, however, and shortly before his second and fatal attack he was smoking as hard as ever. Most victims of these attacks are heavy smokers, usually men. In recent decades, however, women of the younger generation have been smoking almost as much as men, so it will be interesting to see whether they also become more susceptible to this disease through the coming years.

I myself have never smoked much, but even four or five cigarettes a day tend to make my heart beat irregularly and blur my intellect. Many smokers use two or three packs a day without direct evidence of harm, and yet there is a growing feeling that such immoderate use of tobacco may eventually be harmful. Cigars are worse than cigarettes, particularly if they are smoked down close to the butt. The harmful ingredients of tobacco smoke may be largely removed by absorbant filters, but these must be changed frequently to be effective.

It is indeed unfortunate that no clear case yet exists either for or against the use of tobacco. Within moderate limits it may be quite harmless for most people living in regions where stress on the vascular system is not severe; but in the earth's stimulating areas much greater caution should be exercised. Just as with caffeine, it is the restlessness and tension of life in the stimulating climates which lead people into excessive smoking. The act itself is usually an expression of this restlessness and lack of repose, especially cigarette smoking. Hence we see the most excessive and harmful overuse of tobacco among the very people who should be most on guard against its effects.

Caffeine and nicotine are not the only commonly used drugs which have a direct bearing upon man's reaction to climate. Coffee and tea became popular in Europe only in the sixteenth century, about the same time tobacco was introduced from the New World. But alcohol has always been with us and had its large army of devotees back into the most remote recesses of antiquity. Highballs, wines, beers, and the numerous other drinks in such demand to-day have had their counterparts all through human history. Probably the first recorded use of an alcoholic beverage was by Noah as described in Gen. ix. 21, only nine generations after Adam. For revelry and a free flow of emotions alcohol has always been in demand.

Delirium tremens patients who enter our hospitals as complete nervous wrecks, however, represent a type of case seldom seen elsewhere than in the temperate zones. It was perhaps not chance alone that the first temperance crusade took place in the invigorating, stormy climate of the western plains when Carrie Nation, with her axe, led a revolt against the most vicious and destructive effects of alcohol. In warmer regions where human energy is low alcohol produces only a mild excitement phase which quickly passes into drowsiness or lethargy. With energetic people of cooler lands, however, the early excitement phase is more marked and often leads to extremes of ill-considered violence. Alcoholism has a curiously strong tendency to produce troublesome social problems in these regions. Only among energetic people of cool climates is the old Indian term "firewater" particularly appropriate.

The reason for this climate difference in response is found in the effects of alcohol upon the brain cells. It is not a stimulant in any real sense. It does not increase cellular combustion or tissue activity in the way caffeine does. Being a near chemical relative of the simple sugars, alcohol is burned as a food in the cells. Its chief physiological action is upon the central nervous system, particularly the brain. Here it acts as a narcotic with a deadening effect upon the brain cells. The cells of the highest centres in the cerebrum are most susceptible to its action—they are the centres having to do with judgment, moral sense, inhibitions, and with the other high psychic phases of existence. As the cells of these higher centres become deadened by the first effects of alcohol, the centres of lower order are allowed freer play in determining actions and conduct. Basic emotions—those of sex, anger, affection, and the like—thus escape from the inhibiting influences of the higher centres, and existence drops closer to the animal level of direct response to every impulse.

Among tropical people of low energy this release from higher inhibitions means little. Fewer inhibitions are needed or are present where the urge to action is low. The tropical native acts almost as freely when sober as when under this releasing effect of alcohol. He seldom has an excess of energy which requires curbing or which gets him into trouble when his higher inhibitions are dulled by alcohol. But inhibitions are socially necessary among the dynamic residents of cooler climates where tissue fires burn faster. As alcohol dulls the inhibitions, chaotic situations may arise only too readily and lead to disaster.

A man in his early forties came to me recently for advice regarding his drinking habits. He had been happily married for eleven years and had three fine children. The home life of the family had been pleasant in all respects except that a sharp limitation of income had made them live a most economical life. Income had not increased as the family grew in size—it had in fact shrunk during the depression years—and the financial outlook had become more and more hopeless as debts began to accumulate. About a year ago the wife told me her husband was drinking considerable quantities of wine in the evenings after coming home from work. This interfered with his tasks next day and further intensified the family's economic problem.

The man seemed beaten by his long years of worry and lack of financial progress. He had no force left to fight the hold alcohol was taking on him. Only through its deadening influence could he forget his feeling of frustration and despair. He seemed earnestly to desire help, so I sent him to a good psychiatrist—but to no avail. The spirit was willing but the body weak. At present he is attending nignt school, training himself for a better-paid type of work in one of the key defence industries, and seems to have taken on a new hope at this prospect of a solution to his financial problems. But he is still drinking and will need something more powerful than mere hope to bolster his ego. Only real success can now fortify him against the desire for the deadening effects of alcohol.

Here is a man worn down and almost defeated in the keen economic fight to support his family adequately. Alcohol affords him temporary escape from the hard realities of his problem, but its use only makes the situation more precarious. This experience has been repeated in millions of families of every generation back through the centuries and has been one of the chief factors behind the development of the temperance movement in Europe and America. Such people really need sympathy and help, for theirs is an economic failure and alcohol soon robs them of even their small earning capacity. Their problem is most acute in regions where life follows a rapid course and the scale of living is high, for failure shows up most sharply there. Few bother about such matters where tropical complacency prevails.

A fellow investigator at Cincinnati showed that one of the chief damaging effects of alcohol is due to the fact that it lacks the B vitamins. These are just as necessary to facilitate the burning of alcohol in the body tissues as they are for the burning of the chemically related sugars. Normally the foods which supply our tissues with sugar contain these important vitamins, but alcoholic beverages contain practically no vitamins of any sort. In addition, people heavily addicted to alcohol often have little appetite for regular foods because the burning of alcohol has replaced that of sugar. Thus they readily develop vitamin deficiencies, particularly pellagra from lack of proper nicotinic acid and nervous or neuritic symptoms from lack of B_1 or thiamin.

Drinking affects the brain cells immediately because they contain a higher proportion of special alcohol-absorbing fats than most of the body's other tissues. But later brain effects from prolonged addiction seem to be due mostly to B vitamin deficiency. The brain has the highest combustion rate of all body tissues and hence requires the greatest supply of these vitamins catalysts. Jittery, highly irritable alcoholics who are nearing the convulsive stage of delirium tremens now promptly receive large amounts of the vitamins and plenty of nutritious food when they come for treatment.

The drinker who becomes quarrelsome, unruly, and violent under the influence of alcohol has provided society with the most acute phase of the liquor problem. As we have emphasized, he is predominantly a product of the earth's most stimulating climate. His abundance of energy runs riot as alcohol dulls the inhibitions which normally keep antisocial impulses under control. His excesses may take almost any form, but they usually involve the very fields of morality most closely guarded by inhibitions during normal life. Sexual excesses, assaults upon the person and property of others—these are the lines most often followed by his unbridled energy.

In those regions where life is most strenuous, perhaps the most justifiable use of alcohol—outside of its applications in medicine—is the late afternoon or evening cocktail or highball to relieve the brain from the day's stresses and worries. This may be relatively safe for strong and successful persons, but uncontrolled addiction is likely to result among those who find life's battles too severe. Many women of American cities who flounder in aimless idleness are among to-day's heavy users of alcohol. The very futility of their existence inclines them to alcohol and other narcotics which dull their appreciation of life's unsatisfactory aspects. People really do "drown their sorrows and disappointments in drink," but at the same time they frequently drown themselves in permanent alcoholism.

The threat of drinking is especially great among those who migrate from energizing climates into tropical heat. Many of these persons, especially the women, develop a feeling of frustration because of life's slow pace and prevailing physical inactivity. Extremely sad cases of chronic alcoholism have developed among the wives of prominent men who have had to live their lives in the stagnation of tropical service. Heat subdues the tissue fires and leads to less rapid burning of the alcohol absorbed into the blood, thus making such people more susceptible to its narcotic effects.

This is perhaps the first time the alcohol problem has been considered from a climatic point of view, but such an approach is extremely appropriate. It makes quite evident the reasons why the temperance movement is largely restricted to the most energizing regions of the earth. The hard-driven people of cooler lands are most addicted to overuse not only of alcohol but of caffeine-containing beverages, tobacco, and narcotic drugs such as morphine, cocaine, and heroin.

One of the great unsolved problems of life in energizing climates is how to avoid the dangers of bodily and mental stress described in this and the preceding chapter. Scientists and the medical profession are finally awakening to the serious hazards which such strain is bringing to man in regions where his past progress has been most astonishing.

CHAPTER 8

STORMY WEATHER AND RESPIRATORY INFECTIONS

LAST WINTER A WORRIED MAN of middle age came to my office. In approved medical style, we shall keep him nameless and refer to him only as Mr. X. This patient wanted me to help him solve the problem of chronic sinusitis which was making life miserable for himself and his family. As far as physical symptoms went, Mr. X was a typical sinus sufferer, so his case shall be a guiding example throughout this chapter to illustrate the climatic do's and don't's of this most annoying affliction. He differed from most victims of the disease in that he had an intelligent and realistic viewpoint, considering good health more important than money-making. Although a successful Cincinnati manufacturer, he was willing to move permanently to any region where he would have a definite chance to enjoy life more fully. Because of his sane attitude, it was a real pleasure to discuss with him the climatic and weather factors influencing respiratory infections in different parts of the country.

Throughout his life Mr. X had suffered from nasal catarrh—chronic sinus trouble—having lived in the changeable weather of Cincinnati, where the atmosphere is highly polluted with the irritating products of soft-coal fires (soot, silicate ash, and sulphur gases). For generations nasal catarrh had been the curse of his family, just as it is in countless other familues living in stormy regions of the earth.

Both his father and his grandfather had been similarly afflicted. His only child was already developing chronic bronchitis. All members of the family suffered with frequent colds. The entire case history was characteristic of the disease, which runs in families for two main reasons. It often begins because a highly arched palate in the mouth has pushed the central partition of the nose to one side and obstructed the opening to one of the secondary cavities. This was the case with Mr. X. As long as these cavities or sinuses remain open and well drained they cause little trouble. But when the opening is obstructed, every acute nasal infection which comes along settles there for a prolonged stay, and soon a chronic sinus condition develops. Since shape of the face and likelihood of a highly arched palate are strongly hereditary (as our patient learned to his regret), so also is the tendency to chronic sinus trouble. But other causes. such as childhood adenoids and mouth breathing, can lead to the same arching of the palate.

Although Mr. X inherited an arched palate and this is sufficient to explain his case, the second reason why sinusitis may be a family curse is also of interest. One afflicted member of the family is likely to spread the disease into the sinuses of others in the household. Every "cold" organism brought home from outside by the children lodges in that good growing spot, grows merrily in the poorly aired cavity, and becomes more virulent. Later it finds its way into the sinuses of others in the family. Thus one chronic case in a household usually means frequent colds for all and an excellent chance for sinusitis among those persons who, because of hereditary or acquired predispositions, happen to offer fertile fields for infection. Persistent bronchitis and the tendency to frequent colds can often be traced to the presence in the household of a person with chronic sinus inflammations. In one Cincinnati family a change of maids finally cleared up the respiratory troubles. But if the sufferer happens to be a parent, the remedy is not so simple and a change of location might well be considered.

A previously broken nose may also start a long line of sinusitis sufferers. The break usually pushes inward on the nasal partition, bending it and obstructing a sinus opening off to the side. My wife suffered such an injury during a high-school basketball game, but scarcely noticed it until she was swimming two years ago and broke her nose again. Typical nasal catarrh then set in and I sent her to a surgeon for a so-called "sub-mucous resection" or cutting out of the cartilage in the dividing partition. This operation, followed by a mid-winter trip to the steady warmth of Panama, effected a complete cure and probably saved our family much trouble. An interesting feature of the hospital stay was her loss of smell while her nose was packed with gauze following the operation. At the very time when a patient needed to be coaxed by attractive delicacies, she complained bitterly of the poor, tasteless food served. It was not an amusing matter to her, considering the daily rates charged by the hospital. To this day she will not believe that everything seemed tasteless to her simply because she couldn't smell the food odours and that by far the greater part of food tastiness depends on a keen smelling apparatus.

Fortunately, sinusitis is not a fixture in our family as it was in Mr. X's. As it happened, he was not content to sit back and continue under the same conditions which had resulted in generations of ill health. The only thing for him to do was to migrate to a more favourable climate—and that involves the fascinating geography of sinusitis. One thing was certain: Mr. X could not remain in Cincinnati, for this city is extremely stormy, and sinusitis, like high blood pressure, is most prevalent in the world's stormiest regions. As yet no one knows exactly what storm changes in the atmosphere do to our bodies, but they seem linked in some fashion to the initiation of sinusitis and acute respiratory and rheumatic attacks. There is some evidence that our tissues take up more water and swell as the outside barometric pressure falls and then give the water off through the kidneys after the storm centre has passed on. We appear to be somewhat spongelike in this regard, and the change in tissue water content may well interfere with our resistance to infection. Whatever the mechanism of this storm effect, it is true that acute respiratory and rheumatic attacks are most frequent in stormy regions and during the most stormy seasons of the year.

Colds and other respiratory infections are less troublesome during the summer, not because of a greater vitality from the more intense sunshine, but rather because of the reduced summer storminess. Actually, the body's ability to fight infection falls during periods of prolonged warmth and is highest when body heat can be readily lost. Therein lies an extremely important point in connection with any considered change of residence for climatic benefit.

I had to consider these and other factors before telling Mr. X where to move for a happy life. Although Cincinnati is not the worst place on earth for storminess and sinusitis, it certainly ranks high and was no spot for my patient. Similar conditions prevail throughout the upper half of the Mississippi Basin from the Rocky Mountains to the Appalachians, where all respiratory troubles are common. The lower half of the Ohio Valley lies under an even blacker curse. This is probably the chief sinusitis zone in the United States. It also has the nation's highest tuberculosis rate. Cities in the Ohio Valley are near producing fields for the poorer grades of soft coal, and their atmospheric pollution probably intensifies the respiratory disease hazard (this possibility calls for immediate and thorough investigation).

Obviously, neither the Ohio Valley nor Cincinnati would do for Mr. X, and from past experiences I also eliminated many other regions. For example, when I was in Manila a few years ago, I was asked to see another person from Cincinnati who had taken his Ohio Valley chronic sinusitis to the Philippines, but without any relief. We should expect this from the last chapter, which emphasized the storminess there. The northern half of the Philippines lies in the Orient's major typhoon pathway, and these low-pressure storm centres often play havoc in Manila itself. Whether as a result of these circumstances or not, it is a fact that sinusitis, tuberculosis, and the other more chronic respiratory complaints are almost as common there as in the upper Mississippi Valley. On the other hand, the depressive moist heat prevailing in Manila sharply reduces the ability to fight these infections. Tuberculosis runs a rapidly fatal course and sinus troubles go unchecked. Medical friends from Puerto Rico inform me that a similar situation also exists in the West Indies hurricane belt. It is a curious fact that only in these two tropical storm areas are acute appendicitis attacks as frequent and severe as in the Mississippi Valley. For some unknown reason appendicitis attacks also are prone to come on days of falling barometric pressure as a storm centre is approaching or passing.

I explained all this to the Cincinnatian in Manila, but his business and family ties seemed to bind him to a choice of Manila, Cincinnati, or New York City as a place of residence. Of these three locations New York would perhaps offer a slightly less severe respiratory handicap, but none of them offers much hope for relief from chronic sinus trouble. I have not seen this man for several years, but my guess would be that he still has his chronic sinusitis, with perhaps a chronic bronchitis now added to his troubles during the winter months.

Although Mr. X had lifelong business ties in Cincinnati, he was willing to break all connections to get rid of his condition. Parts of Colorado or southern Florida have most excellent climates, but, as far as this patient was concerned, the one is too close to winter storm pathways coming down from the northwest and the other is afflicted by hurricane-type storms which sweep in across the West Indies and northward up the Atlantic coast. When I had told him about this relationship between storminess and sinusitis, I also dismissed certain seemingly possible regions as out of the question. He could have escaped all storm effects by migrating to Panama, Hawaii, or any number of calm tropical areas. Broad reaches of the tropics are free from both the cyclonic storminess of the temperate zones and the typhoon or hurricane types which afflict limited other parts of the tropics. But if he migrated into tropical warmth, the ability of his tissues to fight his sinus infection would be reduced and his troubles would persist. What he needed was freedom from storms without the depressing moist heat of the tropics. Even along the Gulf coast of our southern states the prolonged moist summer heat has this depressive effect.

But there happens to be one important section of the United States where respiratory troubles in general are at a minimum and where chronic sinusitis in particular has an excellent chance of lapsing into almost complete inactivity. Sudden storm changes seldom occur in the South-west, a large and favoured region including New Mexico, Arizona, and southern California. As I pointed out earlier in this chapter, Mr. X was intelligent and anxious to obtain every possible advantage from his change of location. I told him that the climate of southern Arizona or New Mexico would be best for his catarrh, but he was a clothing manufacturer and needed contact with a large urban centre for business reasons. This narrowed the choice quite drastically, leaving only the Los Angeles metropolitan area.

It was somewhat against my better judgment that I finally recommended this area as a future home for this family. Mr. X happens to be afflicted with moderately high blood pressure and some anginal pain over his heart. The dry, non-stormy climate of southern California will unquestionably lessen the family's respiratory troubles, but there is a restlessness and artificiality among the people which will not help this man's coronary trouble. Although the climate of Los Angeles is certainly not stimulating, one is aware of a rush and urgency seldom encountered except in the most invigorating climates. Driving speeds on the main thoroughfares seem faster than in any other metropolitan area. Much of the rush might be explained by migration there of restless people from all over America, many of them seeking quick fame and others diversion from previous dullness elsewhere. Generally life follows a more sedate course in less stimulating climates.

My patient was warned about the disturbing influences around Los Angeles and was advised to establish his home in the outskirts of the city well away from all the hustle and bustle. San Diego would have been an even better place for him to live, but the greater isolation from his business world would have been an added economic handicap offsetting the slightly greater health benefits. Having located Mr. X's future home in Los Angeles and, more specifically, in one of that city's quieter suburbs, I also gave him several important additional hints. For example, I told him to select a home site at as high an altitude as possible within commuting distance of his future place of business. Although daytime heat is dry in the South-west, the temperature is sometimes enervating and even the midday heat is less severe at moderate elevations above sea-level.

Another suggestion was that he live back as far as possible from the coast. You may wonder why I told this patient to stay some distance away from the ocean and its delightfully cooling breezes—but there is a good reason. Air movement there along the coast is always inland, carrying salt spray and mists, so that the climate of the coastal fringe is very different from that of the desert regions some miles farther inland. Nothing seems to benefit sinus inflammation so much as the non-stormy dryness of desert climates.

A few summers ago my family spent the month of August in a cottage directly overlooking the ocean south of Santa Monica and found the cool ocean breezes a most welcome relief from Midwest heat. However, the winds off the ocean were quite moist through the night and most of the forenoon hours. Before the month had passed two of us had developed definite sinus trouble which persisted until we started inland across the deserts on our return trip. Daily bathing in the surf among the massive breakers and churning sand probably did much to keep our sinus inflammation going. It is unwise for a person with sinus trouble to bathe in salt water or strongly chlorinated pools unless he avoids getting water into his nose, because water in the sinus cavities irritates delicate lining tissues. After that experienced with moist California coastal breezes, I could easily see why people with sinusitis or nasal catarrh should locate farther inland.

Mr. X wanted to obtain every possible advantage from his change of location. It takes courage for a man to break off all his lifelong relationships and give up a successful business just to seek a more healthful location, but he had seen enough of the continual misery brought by sinusitis in the Midwest to be willing to face the economic risks of such a move. In my opinion he exhibited a realistic wisdom which a great many other northerners could well imitate. Good health is worth more, even at a lower economic level, than is a life of wealth always overshadowed by physical discomfort and chronic ill health. He intends to move to Los Angeles soon, and I am certain that he will suffer far less because of his decision.

He is probably avoiding a great deal more than sinus trouble alone, for in stormy climates this malady is only the beginning of ill-health. Germ-laden secretions and pus from the involved sinuses drop down into the air passages and lungs during sleep and soon set up chronic bronchitis. This goes on year after year, slowly growing worse with each winter and moderating somewhat with the calm warmth of summer. Eventually the smaller air passages develop dilated portions filled with pus and then the person has bronchiectasis. His cough is then practically continuous throughout the year, with large amounts of foul sputum being expectorated at all times. Every acute respiratory infection acts almost like an attack of pneumonia in setting up severe inflammation throughout the diseased air passages and subsiding at an irritatingly slow rate. For such people life is a dreary round of coughing and expectorating, with one acute flare-up following another through the stormy seasons.

It is this slow spreading of trouble from chronic sinus infections which makes the matter so important for future health. Usually only one sinus cavity is involved at first. The trouble tends to spread to other sinuses, however, then down the air passages into the lungs. Nose and throat specialists can often help clear up a sinus infection while it is still in its early stages, but they usually have little success when it has become chronic. Chronic sinus patients provide lucrative practice for these physicians in stormy regions, but for the victims themselves there is only increasing ill health unless they seek a non-stormy climate.

Respiratory infections are the major producers of ill health in stormy regions. Unfortunately the medical profession has little real help to offer by way of prevention. Drug therapy in pneumonia has made great strides toward conquering the terrors of this disease in the last few years, but colds, sinusitis, chronic bronchitis, and bronchiectasis are still about as stubborn as ever. Migration away from storms offers the only real help for people so afflicted.

While the South-west provides unique health advantages in its freedom from cyclonic storminess, the region is handicapped by its barrenness and cannot support a dense population. A realistic public-health policy could soon remedy this handicap by proper use of mountain water supplies for irrigation purposes and for the generation of electric power to turn the wheels of new industries. A few good steps have already been taken in this direction, but far more must be done before a means of livelihood can be found for more than a small part of the afflicted people who would benefit by migration from stormy regions.

CHAPTER 9

TUBERCULOSIS, LEPROSY, AND RHEUMATIC INFECTIONS

ALTHOUGH ENERGETIC PEOPLE of temperate-zone climates enjoy winter vacations in warmer surroundings, the change in environment may have certain bad effects which should be carefully taken into account. One of our industrial leaders, wintering in Florida a few years ago, was suddenly called back to Cincinnati to meet an unexpected financial crisis. At seventy he was still a vigorous man, active in business and civic affairs. A few days after his arrival here, however, he contracted a cold which went on to fatal pneumonia. The months of southern warmth had sapped his vitality and left him unprepared for the respiratory hazards of northern winters. Although he had been a heavy contributor to the city's medical activities, the medical profession could do little for him. Present effective methods of chemical and serum treatment were undeveloped at that time.

His death emphasized the dangers people encounter in changing suddenly from a warm climate to the stormy cold of northern winters. It is quite common for acute respiratory infections—colds, sinusitis, bronchitis, or pneumonia—to attack persons who come north after having become adapted to tropical warmth. One or two weeks of winter vacation in the south have little softening effect, but with a stay of a month or more the body's vitality declines and resistance to infection is sharply lowered.

During the first week of our return from Panama late in March, all three of us contracted colds in the raw spring weather. We had enjoyed excellent health in the south, but two months of tropical warmth had lowered our resistance. This loss should be an important consideration for those who winter in the south or who spend a longer time in the tropics. A return to cooler climates should be made during the summer, so that the body can gradually become accustomed to cold as temperatures drop through the autumn months.

The fall in tissue vitality which takes place in tropical heat is an element of especially great importance in one of the world's greatest scourges, tuberculosis. No victim of this disease, no matter how inactive it may be at the time, should plan a stay in the tropics. Tuberculosis there progresses rapidly and may easily be fatal unless the person is removed to cooler regions. In the Philippine lowlands, for instance, the tuberculosis death rate is extremely high—cases are numerous and resistance is low. Hospitalization in a sanatorium does patients little good and merely decreases their chances of spreading the disease. But if they are taken into the cool mountains, they wage a much better fight. The resulting improvement is soon lost, however, if they return again to the lowland heat.

Most physicians in the tropics now appreciate the importance of this lowered vitality in hot climates and send their patients out to more invigorating regions as soon as tuberculosis is detected. But the wise doctor will take care that this move does not plunge his patient into the respiratory hazards of winter cold and storms. Here again the dry non-stormy South-west offers the region of choice.

To-day many physicians in the northern states feel that tuberculosis can be handled just as well in the home region as in the South-west—and so it can be if the patient is carefully guarded against the possibility of acute respiratory infections. Each cold he contracts, however, is likely to aggravate his tuberculosis. Northern coolness heightens his general nutrition and vitality, but the frequent storms which accompany this coolness add greatly to the dangers of respiratory infections and more than offset any advantage. Contrary to the belief of some physicians, therefore, the safest course would still seem to be migration to the South-west, away from the disturbing storms. Furthermore, location there should be at altitudes high enough to afford freedom from severe summer heat.

These findings have important implications for the medical examination of American troops selected for tropical fighting. Army and Navy physicians have been carefully X-raying recruits' chests to detect incipient or active tuberculosis, but special attention should be given to divisions slated for future duty in Africa and other hot climates, where the disease would thrive. Native troops, on the other hand, are best fitted for fighting in surroundings to which they have been accustomed from birth—as was emphasized by bitter experiences of the last war.

From 1914 to 1918 tuberculosis became a terribly fatal disease among native troops from northern Africa during the winter months of trench fighting in the mud of France. These men were ill adapted to the wet and cold of northern France. They showed little ability to fight the infection. Three months of high fever and rapid tissue destruction almost inevitably led to an early death, whereas among French, British, and American soldiers the disease followed a slower and less fatal course. Pneumonia, too, and all the other acute infections of the air passages struck with special fury among the tropical troops fighting or serving in France during the last war.

A few years ago I decided to investigate the influence place of birth might have on the ability to fight tuberculosis around Cincinnati. Large numbers of our people—both coloured and white—came from the southern states, while we also have many immigrants from Europe. Our large tuberculosis sanitorium on the outskirts of the city cares for the indigent tubercular members of the population. In going over some three thousand records of patients who died in this institution, I found a striking difference between those of northern and those of southern birth in their respective abilities to fight the infection.

The disease—from first symptoms to death—had an average duration of nine months among Negroes from the Gulf states, while among Cincinnati coloured people it lasted eighteen months.* White migrants from the Gulf states endured tuberculosis for an average of eleven months, but northern-born whites held out twice as long. Like the Gulf-state group, emigrants from Mediterranean countries also survived only about eleven months, while those coming from countries north or west of the Alps lasted twenty-two months. These statistics dealt only with sanitorium deaths from tuberculosis. If we could follow up patients discharged from the institution, we would probably find an even greater difference in the ability to survive.

We should remember, too, that these figures include only tuberculosis among Cincinnati's poor, in whom the disease runs its most rapid course. People of higher economic level and better nutritional state naturally have much stronger resistance, and their chances of final recovery are much greater. During peacetime body resistance to tuberculosis has been increasing in the United States. Even while the country's sanatoria and clinics have remained jammed with patients and carried long waiting lists, death rates have been falling.

Although the disease continues unchecked as a terrible scourge among tropical people, it is being brought under control in middle temperate regions and the ultimate conquest is almost in sight. Freshmen are given tuberculin tests as a routine in most colleges, and the number of positive reactions is declining each year. A positive tuberculin reaction means that at some time germs grew in the individual's body, although they may all be dead and the person entirely well at the time of the test. Even fifteen or twenty years ago a majority of the students gave positive tests, indicating that they had at some time been infected, but to-day relatively few positives are found among northern college freshmen.

Tuberculosis is also a most deadly disease among tropical dairy herds, making the production of safe milk a difficult job in most tropical lowlands. But in the northern United States the herds are becoming even more free of the disease than human beings are. This is due largely to the practice of killing all infected cows, but better feeding and care may also have increased the herds' resistance.

Although tuberculosis in man rarely comes from cattle, it is a curious fact that the decline in the disease should have taken place almost simultaneously in both human and bovine beings. One other possible reason for the almost concurrent decline might involve the enlightened and strongly enforced measures to prevent spread of the disease from sick to well individuals. Most positive tuberculin reactions among young people to-day occur in family groups, indicating direct spread of the disease from one member to another.

There is no specific drug for the treatment of tuberculosis. The main burden of the battle falls upon the patient's own tissues. It is essential, therefore, that the body be provided with plenty of good food, including the vitamins necessary for proper fuel burning in the cells. But good food and vitamins will be of little help if external warmth keeps the tissue fires blanketed down to a slow rate of burning. Cool surroundings promote rapid combustion of food in the cells and a high general vitality. Therein lies the principal importance of climate for the tubercular patient.

A disease resembling tuberculosis in many ways is leprosy, the germs of which are so similar to the tubercle bacillus that it is difficult to tell the two varieties apart under the microscope. Both microbes may produce almost identical changes in the body; in fact, physicians at leper colonies frequently speak of tuberculoid leprosy. So it should be no surprise that the diseases both flourish among people living in depressing tropical heat. Energetic persons of middle temperate regions appear practically immune to leprosy. Among those actually infected the disease is inactive and non-contagious. There are scores of lepers in New York and London who come and go freely without transmitting the disease to others.

In 1935 I went without fear into the wards of the old San Lazaro Hospital in Manila, where the worst cases of leprosy have been housed for centuries. The old plank flooring was being replaced in one wing of the building, and I must admit I had a feeling of uncleanliness as the winds blew into my face the old dust which had sifted through that floor from past generations. In a children's colony just outside Manila I examined early-stage cases and touched skin lesions without danger of contracting the infection. Naturally I used the antiseptic precautions always taken by physicians handling contact diseases.

In tropical heat leprosy is largely transmitted by contact, particularly among household or family groups where infants and children are especially susceptible. Colonies in the past have usually been placed in localities where the disease is worst, so that the patients would not be too far away from their friends and relatives and transportation problems would be minimized. However, I considered it illogical to keep these unfortunate victims in the very climatic conditions which so rapidly promote and spread the disease—especially when we know that it tends to become inactive and non-contagious in cooler regions. Therefore, as a result of this Philippine trip and subsequent studies, I recommended that colonies for the segregation of leprosy patients be established in the most stimulating climates available rather than in the regions where the disease spreads most rapidly.

Our own American leper colony should not be kept at Carville, where the long summers of debilitating Louisiana heat reduce disease-resisting vitality. Instead, it should be moved to the Dakotas, where climatic stimulation is high and physical vigour at its peak. Since no specific leprosy cure has as yet been found, it would seem reasonable to give northern coolness a fair trial. Patients brought to the Dakotas would need careful protection from respiratory hazards during their first winter, but after that the climate's effect should be allowed full sway. Perhaps some day this suggestion will be carried out. Certainly little progress is now being made to lessen the inroads of this disease among tropical people.

In stormy climates the rheumatic ills rank next after respiratory infections as causes of ill health. They are even more closely related to storm changes than are tuberculosis and sinusitis, and consequently migration to non-stormy climates is especially imperative.

A young physician with rheumatic arthritis recently visited me to discuss where he could practise medicine with a minimum of discomfort from his affliction. He had developed the infection in both ankles during his intern year at the hospital and had just suffered his first known rheumatic attack. But his heart valves showed old damage which had probably occurred during childhood at some period before repeated sore throats had necessitated removal of his tonsils. He had spent most of his life in northern Ohio, amid the cold and storms so conducive to rheumatic troubles. Having finished his medical course and internship, he now wished to apply to his own personal problem some of the climatic information he had heard me explain during my rounds of the hospital wards.

Except for the slight rheumatic infection in his ankles and the old damage to his heart valves, this young doctor was apparently healthy. We discussed the dangerous effects of storminess, especially during the winter months, and the likelihood of repeated rheumatic attacks if he continued living in the northern United States. I recalled how some years ago groups of rheumatic fever patients were sent from the North Atlantic states for several months of rest in Puerto Rico. As a result of this step their condition improved considerably. They still had periods of flare-up in the infection, however, although the recurrences were by no means as frequent or severe as those in the north. Patients sent to the non-stormy South-west, on the other hand, have practically no new outbreaks of trouble. Instead, the damage to their joints and hearts gradually repairs itself.

After considering such cases, I strongly advised the young man to migrate to the South-west, preferably somewhere within 200 miles of the Mexican border between El Paso and San Diego. Because of his damaged heart valves, I also recommended that he select some branch of medicine requiring relatively little physical strain. He was already interested in becoming an eye specialist and I assured him that this type of practice would not draw too much upon his limited physical resources. But an eye specialist—or almost any specialist, for that matter—cannot make a respectable living in rural sections or small towns without also branching into other lines of practice. This the young doctor could not do, so his choice of location was limited to Los Angeles or San Diego, as in the case of the clothing manufacturer with chronic sinusitis.

Even if no attack of acute arthritis had occurred and focused this young physician's attention on his rheumatic state, the old heart damage should have been sufficient reason for a change in residence. Heart damage from rheumatic infection in childhood may apparently heal and remain quiet for many years, only to reappear years later as the result of some other infection or circumstance which lowers the person's vitality. Only recently one of Cincinnati's leading physician's—also a faculty colleague in the medical school—was stricken by such a reappearance of old rheumatic vegetations on his heart valves and died a few weeks later. Some years ago a similar fate struck another of our medical school professors who had devoted his life to medical research and teaching, but had done so in one of the world's worst regions for the rheumatic heart trouble he had carried since youth.

"Physician, heal thyself" may be good advice, but it is seldom applied. Yet the future seems more encouraging because present-day physicians are beginning to apply their knowledge to their own health problems. The more they do this, the more certain it is that they will pass the benefits of climatic findings on to their patients. I have received inquiries from physicians throughout the country who want to know how modern knowledge of climate could be brought to bear in solving their personal health problems. It is no small matter for a doctor to give up an established practice and move to a new region where he must begin all over again. The fact that physicians now think along these lines means that they really are coming to appreciate the important part climate plays in health.

One physician in northern Illinois who was troubled with sinusitis and high blood pressure asked me which would be best as a new home site: St. Louis, Seattle, or Houston (Texas). I assured him that a change to either St. Louis or Seattle would bring little help. But Houston, I continued, would be an improvement, since its warm weather would definitely bring about a gradual lowering of blood pressure. As for the doctor's sinusitis, Houston, while by no means an ideal spot, is less stormy than St. Louis or Seattle and would have the least irritating effect on this condition. Incidentally, I emphasized the greater advantages of the South-west, and at last report the physician seemed inclined toward Houston.

A Wyoming doctor in his middle forties also wrote for advice. He was much concerned over the great number of breakdowns he had been witnessing among men of his age and hoped that he could escape a similar fate by strategical migration. Since he had no respiratory or rheumatic troubles, but only a growing tendency toward high blood pressure, I suggested that he seek the relaxing warmth of southern Florida. No word has come as to his final decision.

Every patient I see with active rheumatic infection or old damage to the heart is strongly advised to migrate permanently to the non-stormy climate of the South-west. Many of them find it economically impossible to make the move, and others lack the courage for so radical a step. The matter is of greatest importance for rheumatic children. With them it often means the difference between a healthy and useful life in that beneficial climate and one of increasing disability in northern cold and storminess.

Rheumatic infections are far more common and destructive among poor people, probably because they live on a lower nutritional level and are less able to protect themselves against weather changes with adequate clothing and housing. People of means can afford to send a rheumatic child to a better climate. The poor, however, cannot make such a move, and the child is left to grow up in a climate where it is likely to become an invalid requiring expensive hospitalization on community funds.

In these days of free spending for public welfare, it would therefore seem wise that steps be taken to insure proper care of those afflicted with rheumatic infections. Communities should be set up in the South-west to give them convalescent care and the chance to again become self-supporting members of society. The cost would probably be little more than the total now spent for repeated hospitalization and medical care at home. Time after time I see young rheumatic patients in the charity wards of the hospital who most urgently need to get away from the storminess of Cincinnati winters; yet they are bound by the iron chains of poverty to the very climate which is worst for them.

An attractive young woman recently came to the hospital complaining of acute rheumatic pain and swelling of several joints. Two weeks previously she had contracted a summer cold, and less than two days later her joints had become involved. This reawakening of old joint trouble by a recent respiratory infection is an extremely frequent occurrence. The young woman had contracted rheumatic trouble early in childhood, during repeated attacks of tonsillitis, and had suffered many recurrences of acute rheumatic fever, with marked damage to her heart valves. By careful living she had been able to grow to maturity, marry, and give birth to one child. She had almost died of heart failure during childbirth, had been warned against future pregnancies—and, of course, was taught the proper technique for avoiding them. All stimulants which might increase the load on her damaged heart—such as coffee, tea, and cola beverages—had been removed from her life. In fact all she had left was an existence of minimal activity permanently overshadowed by the likelihood of renewed acute joint troubles.

Born and raised in Cincinnati, she was compelled by poverty to remain in a climate particularly bad for rheumatic patients. Her husband, a semi-skilled factory worker, was unemployed for most of the recent prolonged depression. During the present rearmament activity, however, even semi-skilled labour is in great demand, so I urged that he seek employment in some defence industry located in the Los Angeles area of the South-west. Permanent migration away from cold and storms offers this young woman her only hope of relief from further damaging rheumatic attacks. Her leaky heart valves can never be repaired, but she could live a useful life if she were freed from attacks of new infection every few months. Let us hope that some day steps will be taken to give such patients the benefits of migration.

Rheumatic and respiratory infections probably produce more disability in the stormy middle temperate regions than all other diseases combined. It would be well for people living in these regions to appreciate what storminess means to them in terms of ill health. Usually affliction is endured blindly year after year, without the knowledge that good health might be enjoyed elsewhere. Migration, to be most effective, should be permanent and not merely for a brief period of improvemtnt. Even with the complete recovery possible in the South-west, old troubles are likely to reappear if the person returns to stormy regions.

CHAPTER 10

CANCER

FEW PEOPLE CONSIDER CLIMATE a determining factor in cancer occurrence, but recent studies have strongly hinted that the linkage may be fully as close as it is with heart failure and the breakdown diseases. Cancer is becoming more frequent and coming at ever earlier ages in those same regions of the earth which show in other ways the most severe evidences of bodily stress. Animals in our experimental chambers have also indicated that climate may indeed be a factor of major importance in determining the frequency and killing speed of this disease which takes the lives of more than 156,000 Americans a year.

Cancer occurs about as frequently in mice as in human beings. Through the years of our hot- and cold-room studies thousands of laboratory mice have been under observation for varying periods of time. Between 10 and 12 per cent. of the adults dying in the cold room developed cancer before death, while in the hot room not a single tumour was seen. This coincided so well with the high human cancer rate in cool climates that I decided to study the matter more closely on certain strains of mice known to have an extremely high rate of cancer development. Some cancers in mice seem to be rather strongly hereditary, and in certain laboratories tumour incidence has been greatly increased by inbreeding, mating together the offspring of cancerous parents.

One such strain of mice has been bred to show a high incidence of breast cancer, over half of the females developing tumours before death. Two hundred females of this strain were purchased soon after weaning age and divided into three groups. One group of 67 was placed in the cold room at 65° F., another 67 were put into the hot room at 91° F., while the remaining 66 were kept under the more variable conditions ordinarily prevailing in the outside laboratory air. Close watch was kept for tumour appearance during the next eighteen months. The usual lifetime of a mouse is about two years, and we had intended continuing our observations until the mice died of old age. Failure of the controlling device in the hot room one night, however, allowed the temperature to rise too high and caused the death of all in that group when they were about twenty months of age—but not before they had given us very valuable information on cancer development.

By twenty months of age 14 of the cold-room group had developed tumours, while only 4 in the hot room had. The first mass appeared in a nine-month-old mouse in the cold room. In the hot room not a single case was found until fifteen months had passed. Tumours grew almost twice as fast among the cold-room animals as among the hot-room group and took only half as long to kill the mice after they were first observed. The first mouse to die of cancer in the cold room was only ten months old. The first such death in the hot room occurred at almost nineteen months. The group kept under the variable laboratory conditions developed almost as many tumours as were found in the cold room (13 *v.* 14), but the masses appeared slightly later and grew less rapidly. On examination of all the mice at death, 9 internal tumours were found in addition to those of the breast which could readily be felt before death. These 9 other tumours were distributed 4 to the cold room, 4 to the control group out in the laboratory, and *only one* in the hot room.

These interesting mouse findings are now being checked by lifetime observations on other groups subject to different types of cancer. Although final figures are not yet available on the new groups, it is noteworthy that so far 28 have developed tumours in the cold room as compared to only 9 in the heat. The first cold-room mouse to develop tumour did so when 6 months old, while in the heat the first tumour came at 10 months. None of the hot-room mice of this series have developed more than one tumour mass, but in the cold room 6 have had 2 or 3 masses appear in different parts of the breast tissue. It would seem that the invigorating effect of easy heat loss quickens the metabolism of cancer cells as much as it does that of normal body tissues. If this is true, then cancer must be classed along with the breakdown diseases which received so much attention in an earlier chapter.

Cancers in human populations are suppressed in tropical heat almost to the same marked degree we found with our mouse tumours in the hot room. Cancer death rates along the Gulf of Mexico are much lower than in the upper Mississippi Valley, except for cancers of the skin. For some reason tumours of the skin and mouth are more common in the South than in the North, perhaps because of irritating effects of the more intense sunlight. Most other forms occur with greater frequency among people of the North.

Our laboratory mice also develop skin tumours more readily in heat than in cold. Painting their skin with cancer-producing substance from coal tar leads to an earlier production of cancer in the heat. These tumours grow more rapidly and kill the animal earlier than in the cold. Live cancer cells injected just under the skin also develop into fatal tumours more quickly in hot-room mice. This does not happen when the cancer cells or irritating chemical are injected into the deeper tissues. It seems likely that the richer blood supply going to the skin to facilitate loss of body heat in hot environments gives such skin a more active metabolism and renders it more susceptible to cancer. Human hair grows fastest in hot weather—men must shave oftener.

Cancer is largely a disease of the later decades of life. From 45 years onward its frequency rises rapidly to old age. Since fewer people survive infectious diseases to reach old age in the warmer regions, it was thought that this might account for the lower cancer death rate in the South. Closer study of death statistics, however, showed that the rate among those living in each age decade rose much faster in the North and was 50 per cent. higher among the aged in the North than in the South.

No one yet knows exactly why cancer is more frequent in one climate than in another—nor indeed what causes it in any climate. Early operation and radiation therapy have so far offered the only real hope of cure and then only when the tumour is in an accessible location. All too common now as a cause of death, the disease is certain to become even more frequent as the percentage of older persons increases in the American population. To-day there are only about 8 or 9 million persons 65 years of age or over, but this group will probably have swelled to about 22 million in the United States by 1980—and that means hundreds of thousands more cancer cases. Educational campaigns have made people more cancer-conscious and caused them to seek medical aid earlier than previously. Thousands of lives are saved by the earlier operation of breast tumours, but the general cancer death rate continues its uninterrupted rise.

As scientists delve more deeply into ways of causing and curing cancer in animals, they may find methods for its control in man. Certain coal-tar products are particularly prone to start cancer developments in animals, which suggests the possibility that the combustion products of coal and oil poured out to contaminate the air of temperate-zone industrial centres may be responsible for the present rapid increase in the number of lung tumours. Two decades ago cancer of the lungs was relatively rare in America; to-day it has become the most frequent type of cancer among city males of low-income groups. This form of the disease, together with cancers of other tissues coming into direct contact with the air breathed or nasal mucus swallowed, contributes the great majority of such deaths among men of the poorer classes. Among women cancers of the uterus and breast still predominate.

Dr. Oughterson of Yale University has recently presented statistics which hint strongly that some air impurity may be inciting cancer of the respiratory and upper digestive tract. On going over death records of the last ten years in the New Haven General Hospital, he found that cancer of these tissues was several times more frequent among men on the charity wards than among private-room patients. It was also several times more frequent in men than in women. The difference in tumour incidence between charity and private patients or between men and women was less for tumours of the small intestines, while cancer of the large bowel or rectum was present equally in all groups. Cancers of the breast were also equally prevalent in women of the charity and private-patient groups.

These New Haven findings indicate that some cancer-producing substance is being taken in through the nose and mouth, affecting the poorer classes more strongly than those of higher economic groups and men more then women. This substance must be in the air we breathe, since it involves tumours of the lungs just as much as it does those of the mouth, throat and stomach. It fails, however, to affect the most distant parts of the digestive tract or breast cancer in women.

The finger of suspicion must therefore point to some contaminating material in the outdoor air of the city slums, since it is the poor man who is most affected; and we naturally think at once of the soft-coal combustion products which usually hang more densely over city slums than over better residential suburbs. The New Haven figures should be checked by similar studies in other cities and among rural residents. Perhaps there is much more to the city smoke problem than its æsthetic and economic aspects.

Interest in the contaminated atmosphere of city slums is further justified by cancer studies on animals. The most active cancer-producing substances so far known have been obtained from coal tars. Injections of mere traces of these substances—called carcinogens—produce malignant tumours in susceptible strains of mice, the kind of tumour being determined largely by the type of tissue cell irritated by the injected material. Skin tumours follow their repeated application to the skin, lung tumours follow their continued inhalation of dust particles, and other kinds of tumours their injection into still other body tissues. Investigators working with carcinogens take just as great care to avoid contaminating their own tissues with the materials as they do with cultures of the most deadly bacteria. Watching mice develop the cancer masses and die within a few weeks tends to make the observers cautious. Microscopically and in other ways, these experimental tumours are similar to those occurring spontaneously in human beings.

Late in the last century it first became known that coal tars were capable of causing cancer when the London chimney sweeps were found to be unduly afflicted with cancers of the skin. Still later physicians observed that men employed around gas-manufactueing plants or handling coal tar in various forms were also subject to frequent skin cancer. Tars from soft coals which contain much volatile matter seemed most liable to induce these tumours, although the coal itself was quite harmless. Miners usually have little cancer, except in certain European mines containing radioactive ore, where more than half the miners died of lung cancers before proper safety precautions were finally instituted.

Recent intensive studies have given us much information about cancer-producing fractions of coal tar and about some of the avenues through which they may reach our bodies. Labourers coming in direct contact with tar in their work are not the only victims. Dust particles swept up from tarred roads contain these substances, as do also the dust particles polluting the air of the industrial cities in our energetic northern climates. They can readily be extracted from the soft-coal soot in our chimneys. They volatilize at the firebox temperatures prevailing when soft coals burn with heavy smoke production and pass off with other flue gases. As the gases cool down in the chimney, coal-tar compounds condense on carbon soot and ash particles and are thus carried out into the city air. It is the coal tar on soot which makes it smear so readily and produce the stains so difficult to wash off.

Medical scientists and cancer investigators are not yet ready to say that soft-coal smoke is an important factor in the sharply increasing occurrence of lung cancer in our city slums. But the suspicion that such may be the case is rapidly gaining ground. Direct linkage of any such serious health menace to soft-coal smoke would pave the way for speedy clearance of the smoke from our city atmospheres.

CHAPTER II

SHADOWS OVER OUR CITIES

THE ATMOSPHERE-DARKENING SHROUDS of dust and smoke which hang above so many American cities have often been the subject for a peculiar sort of optimism. In the past people have pointed to the man-made shadows with national pride, saying that the darkness was a sign of prosperity and industrial activity. To-day the fumes pouring forth from United

States factories indicate that the greatest war effort in history is hitting on all cylinders, but the darkening pall over our cities brings with it serious health hazards of major proportions. The picture is darker than the thick smoke clouds themselves. It is a story of increased and increasing disease.

Natural climates are not the only ones affecting human health. Man himself, by widespread burning of soft coal in industrialized areas, has brought about local climatic conditions loaded with the most vicious and dangerous health aspects. Great publicity was given some months ago to the effective blackout of a large industrial plant in the Mid-west by a few switch engines spraying a tarry preparation on to the hot coals in their fireboxes. This method of blackout could indeed well be used for daytime concealment from bombing planes. It needed no special demonstration, however, for such blackouts have long been the winter curse of our soft-coal-burning industrial cities. But the evil effects of smoke on health, as revealed by some studies I have recently made in Cincinnati and Pittsburgh, raise the question whether such blackout for wartime use would not be even more deadly for a city than the bombing it was intended to prevent.

A truly devastating respiratory disease situation has been found to exist in the "bottoms" districts of Cincinnati and Pittsburgh, where crowded humanity lives alongside factories and switch engines which keep the atmosphere heavily polluted with their flue products. Many other cities fare just as badly, although the price they pay has not yet been investigated. St. Louis faced a particularly vicious situation with her cheap high-sulphur coal· from the nearby Illinois fields. There were times when the sulphur gases in her "smoggy" atmosphere became really choking to breathe. She has now passed two winters under a stringent anti-smoke ordinance, and most of her citizens are enthusiastic about the improvement already accomplished. Pittsburgh followed suit with a similar regulation, but heavy war-industry demands for all kinds of fuel has made enforcement impossible until peacetime conditions return.

Other cities—Cincinnati among them—were giving the subject active consideration when the war with Japan broke out. Here in Cincinnati I had been asked to serve on a committee looking into the local smoke situation, with a view to the passage by city council of an effective anti-smoke ordinance. This had necessitated my active interest in the subject and soon brought to me a realization that very little was known regarding smoke's harmful effects upon health. Some study had been given the matter in the Ruhr Valley of Germany and in our own

Pittsburgh, but the published findings were only of a general nature and inconclusive.

I therefore decided to see what specific evidences of harm I could find in Cincinnati and Pittsburgh, choosing these two cities for two reasons. Each has good soot-fall and death-rate data by census tracts or soot-fall districts over a number of years, and each has a local topography which presents sharp contrasts in smoke density. Pollution is severe in the low-lying bottoms districts of both cities and is relatively mild in their hilltop suburbs, especially those situated to the west of the industrial sections. The facts unearthed in this study leave no doubt of smoke's evil effects. The respiratory disease situation thus uncovered is severe enough to demand vigorous action regardless of cost as soon as the war emergency and coal shortage have passed.

The threat is illustrated by the case of a friend of mine from New York who recently stopped for a few days in Cincinnati on his way to the South-west. The weather happened to be lowering, with little movement in the muggy air—the kind that keeps our smoke as a heavy blanket over the low-lying basin area of the city. My friend developed an extremely severe respiratory infection and frantically called for me by telephone from one of the hotels down under the smoke. (The incident happened just at a time when I was out seeking for evidences of its effect upon the city's population.) Unable to find me, he finally called another physician, who sent him to a hilltop hospital.

This man claimed that he was always affected in this fashion if he stopped in Cincinnati during the winter season, and he was convinced that the smoke was responsible. This time he came very near to pneumonia, with considerable fever and acute inflammation well down in the smaller air passages. Treatment with the newer chemicals which have proved so effective in pneumococcic infections soon made him well again, but the experience has only deepened his conviction that our city smoke is dangerous.

Smoke's chief effects are naturally upon tissues of the respiratory system, from nose to lungs, for these are the body surfaces brought into most intimate contact with the dirty air. My search for harmful effects thus centred around pneumonia, tuberculosis, and lung cancer, since these are the respiratory diseases which kill and leave death records for study. Information on sinusitis, bronchitis, and colds would be even more interesting, but these milder diseases rarely kill and no records of their incidence are available.

The pneumonia situation is most striking in its relation to smoke, so let's look at it first. My New York friend was indeed fortunate to have escaped pneumonia, for it strikes with great frequency each winter among people living in the dirty air of our congested industrial districts. During 1937 and 1938 in Cincinnati there were 480 pneumonia deaths among 178,000 residents of our low-lying census tracts and only 160 among 277,000 people of the hilltop suburbs! Three-quarters of the city's pneumonia deaths in only a little over a third of its population!

This was at first thought to be due to overcrowding in the basin area where family incomes are lowest. Pneumonia is a contagious disease, it is true, and overcrowding does tend to spread it from one victim to the next. But this does not explain why the *men* in these areas should have almost three times as much pneumonia as do the women living alongside them! In the cleaner suburban districts men have only slightly more (5 per cent.) pneumonia than their wives, but as smoke pollution increases, the male rate rises much faster than the female. In the dirtiest sections the men have three to five times as much pneumonia as the women!

This greater pneumonia hazard of the city labourer cannot be due to his outdoor exposure to chilling, for men on Ohio's farms have only 5 per cent. more pneumonia than their wives (just as in the clean city suburbs). Nor can it be a result of their low economic status and faulty diet, for men are usually better nourished than their wives. The only reasonable conclusion left is that the high rate is due to the outdoor smoke-laden atmosphere in which the men as a rule spend the most time. Those remaining indoors do not escape entirely but they are much less affected.

In both Cincinnati and Pittsburgh the railroads enter largely along valley routes, and industrial plants have naturally located along the railroads. Major use of soft coal thus takes place in the low-lying districts, and on days of little air motion the smoke from these sources hangs suspended in the valley sections. In both cities the pneumonia death rates fall rapidly with each hundred feet of ascent up from the valley bottoms. The death rate is three to ten times higher in the dirty basin districts than out in the cleaner air of the suburbs.

Tuberculosis deaths are also far more common in the most smoky parts of the city. The rates are many times higher than out in the clean suburban air and are markedly higher for men than for women. Negroes, many of whom have migrated from the South, congregate mainly in these dirty districts and have tuberculosis and pneumonia death rates twice as high as the top rates of the white population. Regardless of race, any group migrating from southern states will be far more susceptible to respiratory infection than will native northerners, but these migrants are particularly unfortunate when they settle in our most polluted districts.

The distribution of soot-fall (both carbon particles and fly ash) in various parts of the city bears a direct relation to pneumonia and tuberculosis deaths: The very districts having most excessive soot-fall are the ones with highest respiratory death rates, while in the cleanest suburban areas such deaths are quite negligible in number.

Most of the city's lung cancers also develop in these same dirty basin districts, people there being about three times more likely to develop the disease than are suburban residents. This form of cancer, too, is several times more frequent in men than in women. That the non-contagious, non-infectious lung disease should show the same relation to soot-fall as do tuberculosis and pneumonia is strongly suggestive that air pollution may be the damaging factor. That men, who are out in the dirty air much more than women, should be so much more afflicted with all three of the lung diseases only adds to the suspicion that air pollution is largely responsible for these health hazards of dirty districts.

In presenting these findings, I do not intend to belittle the evil effects of overcrowding, poverty, and malnutrition which are so prevalent in our basin districts. The harmful effects of smoke are only added to these other hazards which confront the unfortunate residents of polluted regions. It is difficult to assess accurately the relative importance of the various health handicaps they face, but air pollution is probably responsible for many respiratory illnesses than all other factors combined. Since respiratory troubles are by far the most frequent causes of ill health among people of temperate regions, it would seem imperative that steps be taken to eliminate the smoke hazard which so severely intensifies this type of illness in our polluted urban districts. Urgency is dictated not only by common human impulses, but also by a realization of the tremendous loss of man-hours among workers in war industries who are stricken by the smoky excrements of their own factories.

Perhaps most city residents have given little thought to just what materials they are taking in with the air they breathe. The black smoke you see is largely carbon, and you have probably been told that carbon is harmless—may indeed be beneficial. It is harmless if it is pure carbon, but that issuing from smoky chimneys is far from pure. Coal-tar compounds in soft coal are also liberated as gases under the same furnace conditions which produce the black smoke. As these gases cool in the upper chimney, they condense on the carbon and ash particles present in the smoke and are thus carried out over the city. Soft-coal soot from the chimneys of English homes has been found to be almost half coal tar in some instances. High-volatile coals liberate the largest amounts of both soot and coal tar when improperly fired; if burned smokelessly, then both tar and carbon are consumed in the firebox. These tarry substances which condense on smoke particles contain the cancer-producing chemicals used in experimental cancer studies and are coming to be seriously suspected as a possible cause for the lung cancer increase among the people of our city slums.

Along with the carbon in smoke goes a considerable amount of so-called "fly ash" composed of much the same sort of silicate compounds which killed so many hundreds of tunnel and quarry workers exposed to the fine rock dust produced in blasting operations. It was formerly thought that these particles irritated the lungs because of their sharp cutting edges, but now their action is considered to be a chemical rather than a physical irritation. Before proper precautions were instituted, these particles produced deadly silicosis among tunnel workers. But the ailment is seldom seen among city residents exposed to fly ash. It is possible that a lower grade of irritation may be responsible for their increased susceptibility to respiratory troubles. Similar fly-ash irritation in the nasal sinuses probably plays a large part in the prevalence of sinusitis among dwellers in our coal-burning cities. One might expect suburban residents who work daily in the downtown basin area to be affected almost as much as the basin "natives." Most of these people, however, work in indoor atmospheres which are much less polluted and sleep at night under cleaner air conditions.

Carbon soot has been decreasing in recent years, because more factories and homes have installed mechanical stokers and secured better burning of the cheap grades of soft coal. Atmospheric fly ash, however, is thicker than ever because more violent mechanical draughts in fireboxes and chimneys have carried larger proportions of furnace ash out into the air. The great heating plants of industrial, apartment, and office buildings add to the fly-ash problem by their nightly blowing-out of the accumulated material in their stacks. This material should be trapped and removed from below instead of being permitted to escape and contaminate the sleeping city.

Still another important smoke constituent is the sulphur which passes off in the form of oxide gases. Sulphur oxides become highly irritating and corrosive acids when dissolved in water. It was probably this type of irritation which affected the noses and air-passage linings of St. Louis residents and, more than any other factor, inspired that city's successful anti-smoke crusade. Coals burned there have a high sulphur content (3-5 per cent.). At times the atmosphere became really choking from these fumes. Out-of-towners usually transacted their business as quickly as possible on such days and then rushed away to less irritating atmospheres outside the city. Many centres are much more fortunate in being supplied with coals of lower sulphur content, but even so there is still enough of these acid fumes to etch stone buildings and disintegrate outdoor paints and exposed metal surfaces.

Fly ash, sulphur fumes, and carbon soot loaded with coal tar—these are the damaging factors in city smoke as far as man himself is concerned. Cutting off of sunlight is probably the least important loss, for normal winter cloudiness and the acute angle at which winter sunlight strikes the earth in Cincinnati make it necessary for us to get our vitamin D supply from food sources during the smoky season. Considering the matter from the respiratory disease standpoint alone, urban residents are fully justified in taking any steps necessary for abolishing the smoke pollution evil. Several cities are becoming greatly concerned over the situation, and as usual there are economic interests which oppose the needed changes. A half-century ago similar objections were raised against plans for purifiction of city water supplies. It was only the clear-cut demonstration that typhoid and other enteric fevers from polluted water were killing thousands each year that forced the acceptance of water purification. Similarly, purified city air will probably remain a mere hope until enough citizens properly appreciate the health hazards of smoky atmospheres.

If any smoke-abatement programme is to lessen air pollution hazards, it must consider certain fundamental factors. Carbon soot and coal-tar compounds flow into city air almost exclusively as a result of the faulty burning of high-volatile soft coals. Such coals can be burned smokelessly with proper furnace equipment. Hence, abatement campaigns are being conducted mainly along the lines of prohibiting the use of high-volatile soft coals unless proper equipment is available for burning them without smoke.

Few industrial plants (except for blast-furnace operation) use any coals except the cheaper, high-volatile types which are obtainable in largest quantities. Proper equipment enables these companies to burn such coals smokelessly and without loss of unburned fuel through smokestacks. Increasing numbers of home-owners are also installing efficient mechanical stokers for these cheap coals. All that is necessary to do away with the black smoke evil completely is to insist that the rest of the homes and the railroad engines either burn low-volatile coals or obtain equipment for the proper handling of the high-volatile varieties.

Relief from black smoke, however, in no way lessons the fly-ash problem. The ash content of coal is not related to its load of volatile materials or its tendency to smoke when improperly burned. In fact hard coals with almost no volatile matter may yield just as much ash as the high-volatile soft coals. Entirely separate steps must be taken to clear city atmospheres of fly-ash hazards. Better settling chambers or traps for the flue ash, or the use of water sprays to cleanse the chimney gases, will do the trick. Relief may often be obtained simply by avoiding sudden air blasts into the firebox. Many types of home stokers have only one speed for their draught fan, and the sudden air blast as the fan comes on carries large quantities of fine ash up the chimney. A more gradual onset of the draught current would remedy this situation.

Washing of flue gases with water sprays would eliminate most sulphur gases as well as solid soot and ash particles. In fact, this is practically the only method by which the sulphur oxides could be removed. Proper firing to eliminate visible smoke will in no way lessen sulphur-oxide fumes—it might even slightly increase them by providing for better oxidation of the last traces of sulphur in the coal. So St. Louis, even with her stringent anti-smoke ordinance, may find her atmosphere just as choking and corrosive as ever unless she compels spray washing of flue gases. Her water supply would prove quite inadequate for such washing in all her chimneys, but in the larger coal-burning plants water could be used over and over again after proper treatment.

The amount of carbon soot deposited over Cincinnati has been declining in recent years with the increase of stokers and gas or oil furnaces. Greater use of coke has also helped. However, fly ash has increased even more than carbon soot has decreased, so the net health situation is worse instead of better. Evidently some highly technical consideration must be given to smoke elimination before genuine relief can be obtained.

One highly vocal objection raised by certain politicians and economic groups is that nothing should be done which would increase the financial burden of poor people residing in polluted districts. To be sure, low-volatile coals and coke cost more than the high-volatile varieties and are difficult to burn in the makeshift stoves of slum districts. Newer types of firebox arrangements, however, will solve that problem; a two-chambered firebox has been devised in which the coal burns freely on one side while new coal on the other side is being coked by the heat. Liberated gases are forced to burn in the flame of the open side. When new coal is needed, it is placed in the burned-out side and permitted to coke while the heat-treated coal on the other side is burning. With such an arrangement, high-volatile coals could be burned with little smoke in the poorest home.

Lacking storage space for fuel, the poor usually buy their coal in small lots from hucksters. Hence, fuel costs dearly and high-volatile coals are usually used which burn most freely in makeshift stoves. Establishment of city-controlled fuel depots where these people could obtain their own coal would provide better fuel for the same money. New-type stoves to burn even high-volatile coals smokelessly, and with more economical combustion, would save enough on two years' fuel bill to pay for the new stove. Thus the poor need not suffer. On the contrary, they would enjoy lower heating costs and, from a health viewpoint, would gain most from a lessening of the pollution evil.

We have not yet even considered the greatest pollution element in city air, the element most responsible for lowered visibility and winter "smog." This factor is the steam given off from industrial power plants and locomotives. Soot-fall over Cincinnati is in the neighbourhood of a half million tons a year, while the railroads alone liberate about ten times that much steam into the city atmosphere. The steam quickly turns into invisible water vapour during the summer when the air's water-holding capacity is high. Cold winter air holds little water vapour, however, so all added steam then remains as fog to becloud our atmosphere.

For several years I tried to find out just how much steam the railroads actually produced daily in our metropolitan area. Officials made evasive replies and continually referred my inquiries from person to person, bringing me to an utter dead-end as far as information was concerned. But during recent hearings before a committee attempting to draft a municipal anti-smoke ordinance, I did obtain the desired information in a roundabout manner. Upon questioning, the railroad and coal representatives revealed the approximate amount of coal used annually by locomotives operating within the Cincinnati switching area. This was roughly a million tons a year. Each pound of coal burned in a steam engine changes 5 to 10 pounds of boiler water into steam. Using the lower figure of 5 pounds of steam for each pound of coal, I calculated that the railroads alone would add enough water daily to our city atmosphere to give 0·6 grains per cubic foot of air over an area of 50 square miles and extending upward for 300 feet. On windless days the steam would be held within these approximate bounds under prevailing topographical conditions.

This 0·6 grains per cubic foot of air is a negligible amount during summer warmth. Air at 90° F. can hold over 10 grains of water vapour per cubic foot and is not often over 70 per cent. saturated except during periods of actual rain. As midday temperatures drop down below 60° F. through the autumn months, however, the air holds less water vapour, and additional nightly cooling brings it to the saturation point. Engine steam then begins to remain as visible fog instead of disappearing as invisible water vapour. Fogs form even in country districts because of this nocturnal cooling and supersaturation of the air, but their presence in industrial districts is tremendously intensified by the steam liberated from power sources. Thus, no matter how thoroughly city dwellers eliminate smoke and fly ash from the air, they should not expect to have clear winter atmospheres and good visibility unless the steam problem is solved.

The situation is particularly acute on windless winter days when the blanket of industrial and locomotive steam shrouds lower-lying urban districts, at times even piling up sufficiently to hide some of the hilltop suburbs. On such days all the flue products from the city's fires are held suspended or in solution by the steam cloud, and we have to breathe this vile mixture—often for several days at a time. These periods probably play the most important role in bringing on respiratory diseases and general ill health. Fly ash and soot quickly settle to the ground during the summer, leaving the air fairly clear. But during the cold, still days of winter steam clouds hold in suspension all the poisonous flue products, giving us the soupy mixture which has been aptly called "smog" (smoke and fog).

Many large industrial plants use their exhaust steam to heat their buildings in winter. Others might follow this example or at least condense the steam to keep it out of city atmospheres. Just how feasible condensing devices would be for railroad engines is a matter of which I have little knowledge. Already railroads are rapidly changing to Diesel power, however, and if the trend continues, steam may become as outmoded as the horse and buggy. The only other socially beneficial alternative in heavily populated metropolitan districts is the use of efficient steam condensers or electricity. Use of Diesel or electric locomotives would solve both smoke and steam problems so far as the railroads are concerned.

For years I have driven from bright suburban sunlight down into the dense murk of the basin area. And for years I have wondered how long the people of our American cities would continue to tolerate such pollution of the air they breathe. At last they seem really to be awakening to the evils of the foul artificial climate in which they must live. The drive to produce materials for the all-important war effort may stimulate further and faster action by persons who realize that the healthier a nation is, the better it can fight. The first efforts to cleanse American urban atmospheres may fall short of the 100-per-cent.-effective mark. But only by trial and test will it be possible to arrive at a solution of the vital pollution problem. Man may not be able to control natural weather, but he should be doing a much better job in straightening up the mess of his own weather-making.

CHAPTER 12

KILLING HEAT

NORTHERNERS ENCOUNTER STILL OTHER risks than those of natural storminess and the man-made smoky atmospheres over their industrial centres. They are especially vulnerable to the severe summer heat waves which often settle over middle latitudes of the United States. The high-metabolism people of these regions cannot subdue their inner fires quickly enough to meet the sudden difficulty in heat loss. Thus thousands of them may develop heatstroke within a few days' time—and this at temperatures which would not bother tropical residents in the least. Heatstroke—in both animals and men—occurs more frequently in the upper half of the Mississippi River Basin than anywhere else on earth. Most of the deaths occur during the first fortnight of a torrid spell, for the body takes about two weeks to adjust its rate of heat production downwards. After this adaptation has taken place, it can safely stand still higher temperatures.

Heat which kills men and animals in June or early July can usually be endured during August.

All warm-blooded animals protect themselves against excessive heat almost entirely by increased evaporation of water. Their bodies normally lose heat in three ways—by direct outward radiation into the surroundings, by conduction to the air or other materials in direct contact with the body, and by water evaporation from the skin or mouth and air passages. The first two avenues of heat loss can operate to advantage only when surrounding temperatures are below that of the body. They are thus of little help on days of severe summer heat when external temperature is higher than that of the skin. In fact, the body may even be taking up heat through these two avenues, especially if exposed to the direct radiant heat of the sun. Water evaporation must therefore bear almost the entire burden of heat loss in times of real stress.

Water is peculiarly well suited for this purpose. In passing from liquid to vapour form it takes up enormous quantities of heat, cooling the surfaces from which it is evaporated. Vaporization of a pint of water takes four and a half times more heat than is required to raise the water from the freezing to the boiling point. This heat of vaporization is said to go into the latent form, for it disappears without rise in temperature. About three quarts of water vaporized per day would be needed for the average resting person to lose all his heat through this channel. During physical labour or active exercise the amount required would be three or four times that much.

When the body's water-evaporation system cannot meet the extra demands of hot weather and allows too much heat to accumulate within the tissue, the result is a dreaded heatstroke. One of my first experiences with this condition—which strikes animals as well as men—occurred in the Dakota harvest fields where I worked as a hand at the age of sixteen. The victim was a valuable and much-loved horse whose death affected me deeply.

Tom was a light Hambletonian carriage horse with plenty of fire and sparkle to make life interesting on the road, but during the busy harvest weeks he had been pressed into service temporarily as a substitute for a sick mare in the six-horse team pulling the header. This was before the day of tractors or power farm machinery of any sort. Horse-power on the farm still meant horses. Through the hot forenoon sun Tom forged well out in front of his slower teammates, trying to urge them to a faster pace. Such drudging slowness ill fitted his fiery spirit and willing heart. About ten o'clock he ceased sweating and in another hour suddenly began to stagger in the hot sun. His owner, riding the header, had been watching him closely all morning, trying to hold him back to a slower pace. He had noticed Tom's glossy coat changing from wet to dry, but had delayed action until the horse actually began to collapse. At the first stumble Tom was quickly unhitched and his harness taken off, but within five minutes he was prostrate on the ground, and in another half-hour he was dead.

That heatstroke death of the farm's favourite pet and most willing and intelligent servant just about broke the hearts of the farmer and his wife. Many days passed before they could smile again. At that time I knew little about the physiological basis of heatstroke, but experience with human cases in the years since then has indicated that Tom's life could have been saved if he had been plunged promptly into a tank of cold water to take the fever out of his system. But there he was, completely prostrated a half-mile away from any water. We poured the little we had in our jugs over his head and body, but to no avail.

The tragic death of Tom in the Dakota harvest field was typical of a danger for which the wise farmer was always on the lookout. During July and August heat, any horse which ceased sweating while at work was always carefully watched for further signs of trouble. A small drainage ditch ran through our Indiana farm, and we would sometimes dip up water from it to pour over the horses if they began to be seriously affected by the heat. We knew there was little danger as long as free sweating continued.

Other farm animals are much more susceptible than horses to heatstroke, but they are not forced to do hard work out in the fields under the hot sun. Cattle develop fever quite readily. They have a much less effective sweating mechanism and like to stand in water when the weather gets hot. Hogs and chickens have almost no sweat glands and are quickly prostrated by excessive heat—as I learned that hot August day when I neglected to open the feed-lot gate so the shoats could wallow in the mud through the midday heat. Hogs provide their own heat protection if any water or mud is available, but chickens or turkeys like to keep their feathers dry. Their only method of increasing heat loss from the body on a hot day is by panting, which quickens the evaporation of water from the mouth and linings of the air passages.

Even with their efficient water-evaporation method of losing heat, human beings may be affected by the hundreds during particularly blazing periods. The grim symptoms of heatstroke are familiar to physicians. The victim first stops sweating, then developes headache and high fever. He soon collapses and becomes unconscious, with a rise in blood pressure, full, bounding pulse, and dry, hot skin. Death often comes quickly—just as it did to Tom in the harvest field—unless the victims are freed of the accumulated heat. When a heatstroke patient is brought into the hospital, he is immediately placed in an iced bath and massaged vigorously until internal temperatures have dropped almost to the normal level. He is then taken out of the tub and wrapped in wet blankets to get rid of the last traces of fever more slowly. If the massage in the ice-water bath lasts too long, the body temperature may drop far below normal, bringing on a condition of shock. Many heatstroke patients died of such shock before this fact was properly appreciated.

To be most effective, heatstroke treatment must be started soon after the patient has collapsed, and the sooner the better, for the high internal temperature brings quick damage to vital body tissues. Any victim should immediately receive the benefit of whatever cooling facilities are at hand, even though it is nothing more than dousing with a pail of water and vigorous fanning to speed evaporation. Such emergency measures, applied while the victim is being hurried to better cooling facilities, greatly improve the chances of recovery.

Such attacks are common in parts of the United States. In early July of 1934 severe heat settled over Cincinnati, St. Louis, Kansas City, and other population masses living in that portion of the Mississippi Basin, prostrating many people and actually killing over five thousand. Two years later heat came in mid-August and killed relatively few veteran heat sufferers in these cities. Farther north, however, in Omaha, Minneapolis, Chicago, Detroit, and other mid-western cities of similar latitude, this heat was fatal to thousands who were unaccustomed to such acute difficulty in losing body heat.

During the first week of the 1934 heat I went by automobile from Cincinnati to Kansas City, passing through the Indiana and Illinois harvest fields. Horses were dying of heatstroke by the hundreds, and tales of human prostration greeted me at every place I stopped. A hush of awe and dread had settled over the country as the margin between life and death seemed to be narrowing down to the vanishing point. In Cincinnati, ambulances were busy day and night, bringing prostrated and unconscious victims to the hospital for treatment. Body temperatures of 110° F. were not uncommon, and many victims died before they could be placed in the iced baths for quick cooling. In the 1936 heat wave we were somewhat better organized to handle the heat cases, with police and hospital ambulances carrying ice so that the cooling of the victims could begin as soon as they were picked up.

One man working in the railroad yards became dizzy at one o'clock on a July afternoon, felt hot and started to walk home about an hour later. He collapsed after going four blocks, was picked up by an ambulance, and became conscious again only after his body temperature was approaching normal in the iced bath at the hospital. When he reached the institution at half-past three his temperature was 109° F. Twenty-five minutes later in the iced bath it was 102° F. He was then removed from the tub and wrapped in cold blankets so that the last remnants of fever could die down at a slower rate. In another forty-five minutes his temperature was 98.2° and he felt almost normal.

Acute difficulty in losing body heat may affect people in quite a different way, producing so-called heat exhaustion. Its onset, less sudden than that of heatstroke, comes with weakness, prostration, low blood pressure, and weak, rapid pulse. The skin is pale and wet with a clammy perspiration, although in certain cases there may be some fever. Stomach cramps, vomiting, and diarrhœa often accompany heat exhaustion and accentuate the patient's collapse. To plunge such a person into a cold bath—as one would a heatstroke victim—might bring on a fatal shock. What he needs is stimulation and the application of warm packs if his temperature is subnormal.

Another common effect of heat is connected with the body's water-evaporating efforts to keep cool. Water excreted through the sweat glands carries out with it considerable quantities of salt, and people working in hot environments are liable to become ill simply from loss of too much body salt. Muscle cramps, weakness, dizziness, prostration, nausea, and vomiting may occur, with prompt relief when the lost minerals are replaced by simply swallowing salt water. This form of severe heat effect is seen in boiler or furnace rooms, in certain processing plants where the product requires hot moist air, and among all workmen doing hard labour under difficult conditions of heat loss. Under such circumstances men are now advised to keep salt tablets handy for use at the first hint of trouble and to drink salt water instead of regular drinking water. Many offices in Washington, D.C., which is notorious for its scorching humid summers, have a handy supply of salt tablets for desperate employees.

The case of a thirty-year-old coloured foundry employee illustrates quite well the problem of heat cramps. One sultry

June day, while working in the hot foundry environment, he drank immense amounts of water and cold beverages to make up for his sweating losses. About noon he vomited and was seized wth severe cramps in his hands, arms, legs, and abdomen. Large knots of cramping muscle stood out on his body and caused excruciating pain. He was taken to the nearby emergency hospital and given a quart of salt solution—with almost instant relief. Thousands of industrial workers are now saved similar trouble by keeping salt tablets at hand to eat or dissolve in drinking water during periods of excessive sweating. As we might expect from our findings in Chapter IV, some industrial plants are also finding that equal or better protection may be afforded by a few milligrams of thiamin (vitamin B_1).

Bathers often suffer from cramps during hot-weather swimming because of this same body salt loss. Sudden chilling in cold water, after previous perspiration in the heat, brings on the painful symptoms. A similar cramping tendency of the muscles is also present during the digestion of meals when large amounts of salt-containing fluids are being poured into the stomach and intestines for digestion of the food. That is the scientific basis for the warning against going in swimming immediately after mealtime.

But heatstroke is the most common hot-weather threat to energetic northerners. It is important and interesting to know that certain groups among the population are more susceptible than others. Elderly people, especially those with high blood pressure or hardening of the arteries, are most likely to be stricken. Difficulty in getting rid of the body's waste heat causes a speeding-up of blood flow from internal organs to the skin, a process which brings heat to the surface where it can be dissipated more rapidly. This increased blood flow throws greater work on the heart and is liable to bring on heart failure in people whose margin of safety has already been reduced.

Chronic alcoholics are also particularly sensitive to heatstroke. Many victims reveal a history of habitual drinking, or else doctors find they had been drinking just before collapsing in the heat. The relationship between alcohol and heatstroke is probably due to liquor's effect upon the brain centres and a disturbance of the intricate nervous control over the sweating mechanism. Medical experience indicates that alcoholic drinks should be avoided or used sparingly during severe heat. Even in the tropics, where a low combustion rate reduces the danger of heatstroke. people usually forgo strong alcoholic drinks during midday heat.

One of my friends with several decades of tropical experience cautions against hearty beer drinking when the body tissues have been dried out by previous perspiration. To quench one's hot-weather thirst with beer is liable to lead to rather profound intoxication, for the dried-out nervous tissue takes up the alcohol and water quickly and becomes deadened before the alcohol can be burned. A normal person will burn the small percentage of alcohol in beer almost as fast as it can be absorbed into the blood, and as a result beer intoxication is difficult. But when the body tissues lose a great deal of water by profuse sweating, absorption becomes much more rapid and even beer drinking has its dangers.

One attack of heatstroke or prostration leaves an individual far more susceptible to similar trouble in subsequent heat waves. Since doctors have not yet found a way to overcome this sensitivity, heat victims must take special care to avoid future exposure. Proper intake of the B vitamins in adequate amounts may protect them against future trouble to a considerable degree.

City dwellers suffer much more during severe heat waves than do residents of rural areas. This is largely because the sun's daytime heat tends to be stored in the pavements and piled-up masonry of the crowded buildings faster than it can be given off at night. Trapped inside the buildings, it causes indoor temperatures to rise higher with each succeeding day of heat. In open rural areas each day's load of heat is pretty thoroughly re-radiated into outer space at night. Green vegetation also helps in lessening the severity of heat, for it is largely composed of water which absorbs the heat without much change of temperature. The dry earth of cultivated fields, or the masonry and pavement materials of the city, become much hotter under the same intensity of sun's heat than do growing plants.

Highest daytime temperatures are usually encountered in desert regions, for the sand heats up quickly under the blazing sun; but it also cools quickly at night as it radiates its daytime heat off into space. Although tropical regions of heavy rainfall receive just as much heat, the dense water-laden foliage on all sides keeps air temperatures from rising very high; but the abundance of water everywhere, with its load of stored heat, also makes the nights warm and oppressive. Temperate-zone cities, with their towering and crowded buildings of concrete and brick, offer the most severe summer heat problem. It was this problem which led to the development of air-conditioning for summer cooling.

One of the most acute heat problems faced by man is to be found inside the tanks engaged in desert warfare. When closed for action, they quickly become veritable ovens in which the occupants suffer terrible torment. The steel turret readily absorbs the sun's heat and re-radiates it into the interior. Lining the inside of the turret with aluminum foil should greatly lessen this heating-up of the interior; it should also give considerable protection against attack from flame-throwers or the kerosene bomb which now makes of the tank a blazing inferno. If tanks were to be lined with foil and then provided with sufficient mechanical cooling to remove the body heat the occupants produce, it should be possible for the men to work inside in fair comfort for hours. At present the heat problem presents a severe limitation to tank operation in hot weather or tropical climates.

CHAPTER 13

BAD MOODS AND FALLING BAROMETERS

WE HAVE SEEN IN PREVIOUS chapters that people living in regions marked by frequent storms and the accompanying wide changes in atmospheric pressure suffer particularly from respiratory ailments, high blood pressure, and other upsets. Acute appendicitis attacks are most likely to come when the barometer is falling, so much so that knowing surgeons rather expect an epidemic of cases on such days. This disease is most severe and fulminates only in the world's stormy areas; it is mild and infrequent in the more stable climates of Europe and most of the tropics.

But the effect of changing weather can show itself in signs far more subtle than the symptoms of physical disease. People have long known intuitively that their emotions and personalities were influenced by their climatic surroundings. In fact, this awareness is built firmly into the English language with such phrases as "stormy emotions," "tempestuous feelings," and "a face as dark as a thunder-cloud." As so frequently is the case, our closest companions among domesticated beasts provide us with clear evidence of this phenomenon.

Farm animals are often good barometers of weather change, exhibiting a growing restlessness and irritability as a storm approaches. All country children realize this, but those raised in the city have missed the close touch with Nature which comes from such daily associations. Cattle, horses, hogs, and other domestic livestock are in their own ways just as natural as wild animals which roam the untouched forests, and they can teach us many valuable lessons if we will but take the trouble to stop, look, and listen.

Time after time these friends on our Indiana farm demonstrated that sudden weather change is an extremely disturbing factor in daily life. We had with us for years one particular cow which acted as an excellent weather gauge. During clear, settled weather she was a docile and likeable creature, friendly and co-operative; but on days of falling barometer and approaching storm, she became most unruly and erratic.

Nell was an easy and voluminous milker of part Jersey heritage, but too unreliable for me to handle in my very early years. Almost as soon as I could reach, I began helping with the least excitable cows at the morning and evening milking. They were usually milked outdoors in good weather, and it was my duty to bring them in from the pasture. Many snappy autumn mornings I would warm my bare toes under some friendly bossy before rousing her from her pasture bed.

In my later childhood Nell and I were particularly good friends most of the time. I loved to play jokes on her and she retaliated now and then with a well-placed kick which sent me and the milk pail tumbling. There was no meanness about her, though, for her big soulful eyes assured me all was forgiven as I clambered up from each such balancing of the score. I soon learned, however, to treat her with respect, especially on the off-weather days, when her temper became brittle and her sense of humour non-existent. On one such lowering June morning she most unceremoniously boosted my mother over a six-foot gate, while we were trying to take away her week-old calf. Even to-day, at eighty-two, mother becomes irate when the memory of that undignified handling is revived.

One of my jokes on Nell still doubles me up with laughter whenever I recall it. It occurred on one of those restless evenings before a storm, when flies and mosquitoes had made milking difficult and kept everyone on the move. Just at dusk I carried out a basketful of corn nubbins for the cows, since scarcity of rain had made the pastures short. Corn to them was like candy to hungry children, so they quickly gathered around for the treat. To the first nubbin thrown out I had attached a long piece of thread, and just as Nell's nose touched the corn I gently pulled it away. She followed it a step or two, then her ears went forward in wonder. Puzzled by this mysterious behaviour of the nubbin, she regarded it closely a few seconds, then cautiously reached for it again. This time, as it moved away just beyond reach of her hungry tongue, she emitted a low, rumbling groan. A wild look came into her wondering eyes. One more twitch of the corn and around the corner of the barn she fled with a terrified bellow, tail pointing high. She might have been as puzzled, but probably would not have been as emotional, if the trick had been played on a rising-pressure day.

Horses, especially the more excitable ones, are also very likely to behave in unexpected ways when the barometer is falling. They become more irritable, fighting each other and frequently disobeying orders. On stormy days they are most inclined to bolt at the slightest opportunity and provide the disastrous runaways which farm children remember so vividly throughout their lives. Hogs, too, fight more among themselves on these days—in fact, I suspect that an hourly count of their fights through the week would provide a good measure of barometric changes.

Man's closest companion, the dog, becomes restless and goes off on his longer scouting trips when a storm is approaching. In one large American city with a leash-law all loose dogs are picked up and taken to the pound. The pound-keeper insists that dogs smell approaching storms and run out to take their exercise while they can. His pick-ups are much more numerous on days before bad weather begins. It is only the restlessness common to all species, however, which drives the dogs into unwonted activity when the barometer is falling. Like the farm cattle and horses, dogs also are more perverse then and likely to snap at a friendly hand. For safety's sake, confine your petting of strange canines to rising-pressure days.

Fishermen given to the telling of tall tales become highly excited about the way fish rise for bait at certain weather phases. Anglers' journals have discussed the matter at great length, finally concluding that barometric pressure change is probably responsible. A dozen fishermen scattered over a lake may have been casting for hours or days without luck and then have the fish suddenly strike at every cast made. As a boy I recall that fishing in our gravel pit was best the day before bad weather set in, when the barometer had just begun to fall. Several of my scientific friends who are rabid anglers take the matter quite seriously.

People are no more immune to the psychological effects of weather change than lower creatures, although the notorious pride of *Homo sapiens* usually prevents him from admitting it. We all like to blame our occasional "blues" on concrete, reassuring things, such as worries about the future, and during domestic squabbles each person is dead sure the other person is at fault. A wiser course might be to take a look at the barometer, for human beings respond just like other animals to falling atmospheric pressures and approaching storms. Family members are more irritable on lowering days, when husband and wife snap at each other and the children seem perversity incarnate. All of us remember the low-barometer evenings when we arrived home exhausted from a day in which everything went wrong only to find the whole family on edge and intolerant of every suggestion. Each person is inclined to overlook his own irritable state and blame any unpleasantness upon unreasonable attitudes of others. Those are the evenings children are chastised because a parent is tired and irritated, although it is true the children themselves are more likely to be unduly perverse.

A heavy rain clears the air at such times in more ways than one, for then the barometer usually begins to rise and good nature again prevails in the home. Even in their sleep many people are restless before a storm, tossing with vivid and nightmarish dreams. Our whole family sometimes awakens when a low-pressure crisis comes along in the middle of the night, and inquiry of other people next day frequently reveals many instances of similar behaviour. So, do not always blame a child's wakefulness or his refusal to eat what you thought good for him upon mere perversity—it may be only the weather!

Perhaps the children of tropical natives are well behaved because they are not subject to the frequent weather changes which disturb temperate-zone residents. Human relationships everywhere would be more peaceful and unruffled if people would only realize the effect of weather on their dispositions and make proper allowance for little flare-ups. Try it out on your own family; you will soon have them laughing off situations which previously led to disagreeable bitterness. When my wife and I look at our children asleep after these quarrelsome evenings, we often wonder how we could have been so severe. But our resolve always to keep good-natured with them usually lasts only until the next period of low pressure.

People subject to severe headaches or fainting spells most often have their attacks when the barometer is falling. Attempts at suicide are then much more likely to occur. Low spirits and an inability to think clearly lead to a feeling of frustration and hopelessness in many people. At such times life seems scarcely worth while; but as the storm passes on, everything assumes a more cheerful aspect.

A few years ago in Tokyo statistics showed that people were more forgetful on low-pressure days. When the barometer was falling, bus and street-car passengers left more packages and umbrellas on the vehicles and put an extra burden on the lost-and-found department. Traffic accidents in American cities are also most numerous in such weather, but in many cases the drivers may be hurrying to reach their destinations before the storm breaks. Industrial accidents, however, show this same increased frequency on days of falling pressure. Even childbirths seem precipitated in veritable epidemics at such times, according to some of my obstetrical friends.

Some people, hypersensitive to weather change, respond to every cloud which hides the sun. Sunshine and shadow keep their emotions jumping from elation to depression, and on days of steadily falling pressure they become morose and dejected. The exact mechanism by which such weather changes affect human beings in so many ways is not yet known. One of my fellow investigators in this field, Dr. Petersen of Chicago, believes it's all due to shifting chemical balances in the blood and body tissues, and he may be right. Other preliminary findings indicate that our tissues take up more water at such times and a resulting slight swelling of the brain may upset us emotionally. Since the evidence is not yet entirely convincing, we can only say that so far we do not know.

When we are equipped for close study of pressure change effects under controlled laboratory conditions, we will probably find just why these things happen to us—and perhaps how they may be avoided. They result only from several hours of falling pressure acting on our tissues, for quick ascent in an elevator or airplane is apparently harmless. Investigations of pressure effects are being greatly stimulated by the marked increase in air travel—both civilian and military—and no doubt researchers will soon be able to report interesting results.

Even though the reason for such effects is a mystery still, proper appreciation of their presence will take much of the stress and unpleasantness out of life in stormy regions. In my own family, greater tolerance is exercised on those days when we know we can expect each other to be more restless and irritable. I have learned in my own work that some days are good only for routine jobs, while on others difficult tasks are readily accomplished. A falling barometer is particularly bad for the type of cerebration required in writing, so much so indeed that paragraphs written under such conditions usually need complete revision. For highest quality output give me an early morning of rising pressure and a cup of fragrant coffee! Lines written then are scarcely recognizable as my own after the caffeine effect has worked off and the pressure has started to fall.

If you are in business, avoid your most difficult customer on falling-pressure days. His instinctive reaction is most likely to be curt and unfavourable; he will look upon you with a suspicious eye. Call on him when fair weather and a rising barometer are standing by as your allies. If you must give a lecture or make some other sort of public appearance, pray that the weather may be clear and cool. At such times, even the feeblest attempt at wit will be appreciated and your delivery will be at its peak. Attack your most difficult problems on the mornings of rising-pressure days, when to the favourable weather there is added the barometer's daily climb from its post-midnight low.

Some day, when we know more definitely just what falling pressure does to our body efficiency, perhaps we will have school buildings equipped for pressure control. Then we may eliminate those days when both teachers and pupils are inefficient, when everyone is restless, irritable, and susceptible to wandering attention and blurred intellect. The control of indoor pressure will probably be one of the future's major developments in indoor conditioning, and its first application should certainly be to school buildings. We shall have more to say in a future chapter about man's effort to create made-to-order weather.

CHAPTER 14

CLIMATE AND HUMAN REPRODUCTION

THOSE WHO HAVE SPENT THEIR lives studying the dim corners of the subconscious mind tell us that stronger even than man's tremendous drive for self-preservation is the deep-rooted urge to preserve his species on the face of the earth. The destructive forces of the most violent wars, including the present conflict, are puny when compared with the long-term interplay of great forces which make for larger populations. By the year 2000 the world will probably house a half-billion more persons than it does to-day—wars or no wars. Despite the fact that reproduction is one of the most vital of all human functions, however, many of the factors influencing it are still a great mystery to modern science.

What are the reasons for vast population trends? Why is fertility declining in England, France, and the United States and rising in Japan and Russia? Although complete answers to these and other questions are impossible, scientists have studied certain factors affecting the general picture. Diet plays some part, but the exact effect is not at all clear. Animal-breeders are aware that proper food and vitamin supplies are highly important for the best reproductivity. But in human beings we see highest birth rates among the most poorly nourished third of the population. For some unknown reason, women run down with advanced tuberculosis or other weakening disease are often quite fertile.

The economic factor is undoubtedly important. Perhaps you, like many other moderns, feel that reproductive fertility is more of a curse than a boon. Children are no longer economic assets, it is true, since unlimited and cheap mechanical power has taken over so much of the world's work. Expensive standards of living make child-rearing and proper education a considerable economic burden, particularly if the children attend college. Hence is it that married couples are coming more and more to consider children a luxury which automatically deprives them of many other pleasures in life. Most modern women look forward to a first child as one of life's greatest experiences, a few welcome the second, but beyond that it is only the unusual mother who does more than tolerate further progeny as an unwelcome result of marital relationship.

There is nothing, however, which enriches adult life as much as the rearing of a family. Overpopulated though the earth may be, with more power already available than man knows how to use, children still are among the most essential ingredients of a well-rounded existence. Of course we want them to be blessed with lusty health and vigour so that repeated illness will not burden us with worry and economic drain. Ability to reproduce well is therefore still an important part of life, and we should be interested in the factors which favour or hinder it. Here is where climate and the seasons enter the picture, for temperature of the environment and rate of food burning allowed in your tissues dominate your reproductive powers. The following pages of this chapter will show not only that your own fertility is highest during certain seasons, but that you can take advantage of this important fact. If you select the proper time of year to conceive a child, its chances of success in life and good health will be tremendously increased.

Your fertility is highest when outdoor temperatures range around 65° F.; conceptions then occur most readily and the offspring are most lusty. Winter temperatures averaging below 40° F. make you somewhat less fertile, even though you may be more active physically; and as mean summer temperatures climb above 70° F. you decline in both fertility and bodily vigour. You probably had no idea you were so affected by changes in temperature and would like to have proof that it is so. You cannot very well test it out on yourself without encountering troublesome social difficulties, so look instead at the fluctuations in fertility other people show as mean temperatures go up and down through the seasons.

Live-birth statistics paint a vivid picture, if the births be dated back nine months to the time of conception. Birth in itself is of little importance, even though we do celebrate it every year as long as we live; it is only a more or less inevitable outcome of earlier events. Of much greater importance are conditions prevailing at the time of conception, when the characteristics and vitality of the parents' germ cells unite to mould the offspring's future. Throughout pregnancy the mother only nourishes and shelters the new life as it starts unfolding.

Starting at Montreal, where summer warmth is never depressive, fertility hits its peak in midsummer and sinks lowest during the steady cold of winter. In Boston there is slight reduction during July and August when mean temperatures rise slightly above the 70° F. line, but in Cincinnati this summer drop becomes more definite. In the steady moist heat of Charleston's summer the fall in reproductivity becomes marked, but it is followed by good recovery through the autumn coolness. Even more striking reduction is found at Tampa, conceptions being fully a third less during summer heat than during the mild winter coolness.

Japan and other countries blanketed by the extremely depressing heat of the Oriental monsoon summer show the most extreme fertility changes. Japanese conceptions reach their peak during the cherry-blossom season, when most nearly ideal weather conditions prevail (April to June). With the onset of monsoon heat in late June, reproductivity takes a nose-dive and remains at a low level until October coolness initiates a slow revival. Marriages in Japan also reach a high peak at the cherry-blossom season, but even if every wedding were followed by immediate conception, not over a tenth of the season's rise in conceptions could be thus accounted for.

The beauty of the blossoms themselves helps to make that season the most emotional one in Japan, so temperature may not be the only factor responsible for the high conception rate. Until the present war with Japan broke out, much had come to be made of cherry-blossom time in Washington also. Perhaps it is significant that even before war began steam shovels were uprooting many of the trees lining the drives in Potomac Park. A few years ago, several thousand of the trees were planted in one of Cincinnati's parks which has since become quite popular for outdoor evening dancing. I shall watch with interest for their effect upon the city's birth rate!

A few years ago one of my colleagues spent some time as visiting professor at one of the large Japanese universities. He became interested in houses of prostitution (a purely platonic interest, of course!). Such places in Japan are closely supervised by the authorities, and the compilation of complete and detailed statistics shows that Germany has no monopoly on Teutonic thoroughness. Every day the keeper of each house officially informs the police exactly how many patrons were received. These figures, obtained by the professor, show no significant reduction in the use of brothels during the monsoon summer heat. A Japanese friend tells me that sex relations are fully as active in summer as at other times of the year. The summer decline in conceptions must therefore represent a true reduction in ability to reproduce.

It has been suggested that the reduced summer conception rate of America's middle and lower temperate latitudes may be due to longer hours of outdoor work during that season, with a higher rate resulting from winter idleness. The same reasoning fails to hold farther north, however, where highest conception rates coincide with summer activity and lowest rates with the long winter nights. The condition is one of real alteration in biologic fertility and can readily be brought about in laboratory animals by changing only their ease of heat loss.

Our hundreds of white mice kept at 65° F. became so fertile that practically every mating resulted in prompt conception. The litters were large in number and of high vitality, with very few stillbirths or infant deaths. Within two weeks after the temperature of the mouse quarters was raised to 90° F., however, conceptions were difficult to achieve and litters were small and puny. Many animals were born dead and many more died before weaning age. These differences occurred even though mating was carried on just as freely at 90° F. as at 65° F. The reproductive organs, studied under the microscope, showed reduced activity in the heat. Complete sterility can be induced by raising the temperature three or four degrees higher still.

The use of artificial fever machines has demonstrated that human reproductive organs also lose their potency for several weeks after as little as a single five- or six-hour fever treatment. Production of spermatozoa is exceedingly low for the succeeding month. There have also been instances of valuable race-horses rendered permanently sterile by a single day of excessive heat. A Kentucky blue-grass colt became overheated one sizzling day while his car was standing in the railroad yards of a certain city awaiting an outgoing train. He apparently recovered, but had lost his racing edge. Sold for stud purposes, he was later found to be completely sterile.

Breeders of small animals around Cincinnati frequently find that their charges are almost completely sterile by the end of a hot summer, while the same rabbits, mice, or guinea pigs kept in cooled quarters continue to reproduce profusely. One beautiful male rabbit, known to be highly fertile, was overheated in our laboratory hot room, but recovered to apparent good health. Afterwards, repeated matings showed him to be permanently sterile.

In Panama warmth the prolific guinea-pig becomes a poor breeder, improving slightly during the short dry season, when low humidity renders the warmth less depressive. Large numbers of guinea-pigs are required for certain hospital and laboratory procedures in Panama, but those imported from the north endure the heat poorly and are of little value. Last year we equipped a room for 70° F. temperature and found that pigs placed in its coolness almost at once regained their famous productivity.

During the severe heat of the 1934 summer in the Middle West, human fertility was sharply reduced. Kansas City showed a 30 per cent. reduction in conception rate during the month when midday temperatures regularly rose above 100° F. (The usual summer decline is only 15 per cent.) All through the Middle West birth statistics showed the same sharp decline for conceptions during that period of blazing heat.

Thus, prevailing temperatures profoundly affect reproductivity which—depending on the weather—may vary all the way from 100 per cent. fertility to complete sterility. But the problem is not merely one of your own capacities; temperatures not only affect the number of progeny, but also their vitality and ability to survive. Human stillbirths and infant deaths are most numerous at high temperatures, just as we found with our laboratory animals. Since you may be more interested in the quality than in the quantity of your children, you must remember that the healthiest offspring are conceived during the season when your own fertility is greatest.

My parents were practical people, with little faith in the sayings of crystal-gazers or fortune-tellers. They sought no horoscopic reading of their children's destinies. To them one month of birth was as good as another, even though they recognized season as an important factor in animal breeding. Their six children were born in six different months—January, April, May, August, September, and December.

In those days there was no evidence that the season of conception exerted a marked influence over the child's entire future. If my parents had even suspected that winter or early spring conception would confer distinct advantages on their offspring, *I am sure they would* have made every effort to give us such benefit. At that time, however, it had not been shown that the volumes of *Who's Who* are largely filled with the names of people conceived during the winter or spring months, that people conceived then tend to live several years longer, and that the likelihood of their entering college is almost twice as great as it is among those conceived in midsummer heat.

This knowledge was not even available during the years when my wife and I were raising our own children. However, my older son and his newly-wedded wife have already been told of its implications and importance for the future of the children they intend to rear. My daughter and younger son also became keenly interested in the subject as they read the preliminary manuscript for this chapter. Most people wish to give their children all possible care and advantage in life, but few realize that their efforts should begin even before their children have been conceived. Optimal health and vigour in the parents are just as important as season of conception for the child's future, but few couples consider this important fact. The facts here presented, however, will be of great interest to those forward-looking few who desire to give their children every possible advantage.

Investigators in various countries have studied the influence exerted by season of birth, but Ellsworth Huntington, research geographer of Yale University, has gone into the subject most deeply. His book, *Season of Birth, Its Relation to Human Abilities,* is not recommended as light reading, but it does contain a wealth of interesting information.

Every mother may not expect her son to become President, or sit among the nation's mighty, but she hopes to see him rise somewhat above the common level. She and her husband can, if they will, greatly increase the son's chances for success in life. The child's hereditary background becomes definitely fixed when his parents wed, but the activation of his inherited abilities is largely determined by the physical environment under which he is conceived and lives.

Prospective parents of middle temperate latitudes should keep in mind that their own bodily vigour goes through a yearly cycle, rising to a peak in the spring, declining sharply through summer heat, and then recovering again during the autumn and winter. Among the thousands of prominent people in *Who's Who*, conceptions rose steadily through winter cold to a high spring peak and then declined sharply to the year's low point in midsummer.

Your child stands the best chance of being a success if he is conceived during the season when conceptions are most numerous in your locality. To be sure, criminals and certain types of the insane are also more frequently conceived during the same optimal season, but the dividing line between genius and insanity has always been a narrow one. Proper selection of a mate should reduce the chances of insanity developing in your children, while the right kind of home environment will go far toward suppressing criminal tendencies. If you prefer the greater safety of mediocrity for your children, then you should choose the less vital seasons for their conception.

Washington and Lincoln were both born in February. Their greatness was probably due to the fact that they were conceived in May at the year's peak of vitality, for American pre-eminence has always been closely associated with spring conceptions. Twenty-seven of our thirty-one presidents were conceived during the eight months from December to July, and only four during the remaining third of the year. Not a single President was conceived in August heat, or born during May or June. Eleven of the 31 were conceived the first quarter of the year, 10 in the second, 4 in the third, and 6 in the fourth. Let those figures be your guide in choosing the season of conception for your children—not in the hope that each of them will become world-famous if properly conceived, but simply so that they may be given this potent advantage in later life.

As a start toward future greatness, you probably hope your child will be able to obtain a college education. If you have ample means, this may worry you little; but those means may be dissipated in the world turmoil now going on before your child is ready for college. It would be safer to have him conceived during the season which starts him off with sufficient energy to carry him to college on his own initiative. In the northern United States a youngster conceived in March is half again more likely to enter college than one conceived in August. Far greater parental vigour seems transmitted to offspring conceived from December to March—vigour which drives the new individual ahead to develop faster, live longer, and accomplish more. Even puberty shows a significantly earlier onset in those conceived during winter cold.

Season of conception affects the vitality of the offspring much less as one goes south from middle temperate latitudes into subtropical warmth. The cool season still is best, but its benefits are less striking. In real tropical heat there is no optimal period—vitality is low at all times of the year. Prospective parents living in the tropics who desire to practice the highest type of eugenics and give their children all possible benefits should spend several months in northern cold before conception takes place. One young couple in Panama, hearing these facts, congratulated their infant on having such a fortunate background, for they had spent several months in Canada just before conception occurred.

Probably much of my own restlessness and driving curiosity has resulted from a fortunate March conception—at the very peak of vitality for the latitude of my birthplace. One of my children is also fortunate, with the background of a February conception, but the other two were conceived in October. If I had only known earlier of this ingredient in the recipe for advantage in life!

These remarks presuppose active timing of conceptions by prospective parents. Such control is widely practised, however, and promises to become even more so as new marriage laws compel young people to undergo medical examination before a licence can be issued. These laws bring people more in touch with physicians, many of whom are quite willing to assist intelligent couples in properly spacing their conceptions.

As we emphasized earlier in this chapter, widespread use of inanimate power on farms and in industry has tended to displace man-power and has made a child more of an economic liability than an asset. This change is probably responsible for the sharply declining birth rate and the increasing number of childless marriages. There were ten children in my mother's family, seven in my father's, and six of us at home during my childhood. But the six of us have a total of only eight offspring. Average family size has declined from six to less than three children within one generation. Since quality must now take the place of quantity in human reproduction, parents should carefully consider the seasonal and climatic factors which alter the quality of their progeny.

Keen intellects and high vitality will be at a premium in the troubled decades of future world reconstruction. Children conceived during the most favourable seasons have an exceptionally good chance of possessing these qualities—all that is required is proper parental foresight. See to it that your offspring never look back as adults and blame you for lack of such thoughtfulness!

CHAPTER 15

MADE-TO-ORDER INDOOR CLIMATES

WE CAN DO NOTHING about curbing or modifying the vast outdoor climatic and weather forces which have so much influence on our vital rhythms and health. But in Chapter 11 we have already shown that a socially minded community can and should do a great deal to control the man-made climates which result in the great clouds of dust and other potentially dangerous combustion by-products over our industrial centres. Another method of handling the problems of our surroundings is to escape from them into that form of localized artificial climate known as air conditioning.

The benefits of such artificial environments may be illustrated by an interesting case in Manila. In a local factory 100 Filipino women were busy wrapping and packaging sticks of bubble gum. The manager had installed cooling equipment to maintain a 65° F. temperature so that the gum would be kept hard while being handled. This he had done with many misgivings, since Filipinos were extremely sensitive to chilling. The labour supply there was plentiful, however, so he had gone ahead. Bundling the women up in sweaters, shawls, woollen dresses, and stockings, he had advised them to eat lunch in the workrooms and to leave the wrapping room only at the end of the day. They thus had avoided the shock of frequent change from indoor cold to outside does not require a warming of the air in winter or the cooling of it in summer. I refer to reflective radiant conditioning, as demonstrated a few years ago in my laboratory, in which all warming or cooling of the room occupants is done entirely through radiant channels.

Heat or infra red rays travel through the air at the speed of light or radio waves (186,000 miles a second) without any appreciable warming influence. Their warming effect occurs only when they strike some solid body which can absorb the beams. The absorbed rays cause the atoms of the object to move violently, and the resulting kinetic energy of motion produces heat. A person's heat loss can readily be controlled through radiant channels alone, no matter how hot or cold the surrounding air may be, if arrangements are made to govern the amount of this radiant heat falling upon or leaving his skin surfaces.

Everyone knows the sharp contrast in comfort between standing in deep shade and out in the hot summer sun, even though actual air temperatures may be the same in both cases. And in cold winter air, it matters greatly whether you are on the sunny side of a building or in its shadow. Those enjoying winter sports on the mountain slopes of Switzerland or Idaho are kept warm by the sun's radiating heat waves reaching them through zero air. European air-conditioning engineers made some use of this principle by imbedding hot water pipes in the ceilings or floors so that the warmed surfaces might radiate heat to the occupants. Remember that this is radiant heat, the kind which does not raise the temperature of the air between its source and the absorbing object. They thus succeeded in achieving comfort at air temperatures ten degrees cooler than those required by American air-conditioning methods.

Scientists at one large industrial concern in America tried for several years to perfect a method for winter heating and summer cooling through control of wall temperatures. Using metal wall surfaces, they could make lightly clad persons quite comfortable in zero air by having the walls radiate heat. Many persons understand this sort of situation in which heat rays pass through air, strike the body, and warm it as a result, but they find it difficult to grasp how heat may be removed from the body by radiation. The main point is that the body, like any other object, can *lose* heat by emitting infra red rays, and, if the walls of a room are cooled instead of heated, these rays are removed from the room confines as fast as they are given off from the skin.

The researchers proved this by placing persons in the room at 110° F. Then they lowered the wall temperature. Despite the sizzling heat, the subjects relaxed comfortably because their bodies were able to eliminate the excess heat by radiation. These tests were interesting and valuable. Judging by their skin sensations, occupants of the experimental room often could not guess whether they were in cold air or warm. For some reason, the hot air was not even disagreeable to breathe when body skin surfaces were losing heat readily to the cold walls. In quite thorough fashion, the scientists demonstrated that bodily comfort could be obtained by control of wall temperatures regardless of prevailing air conditions.

The studies were finally abandoned for two reasons. There was no way of controlling wall temperatures within reasonable economic limits, either for construction costs or for maintenance; and walls chilled for hot summer weather were always wet with water which condensed upon their cooled surfaces. Obviously, no heating system will sell if its hot-weather operation causes wall surfaces to drip with moisture.

In my laboratories the radiant idea was carried a step further. Instead of using hot or cold wall surfaces, I covered all the inside walls of an experimental chamber with aluminum foil. It is a highly efficient, mirror-like reflector of all heat rays, so much so that its surface temperature rises very little even when intense heat is directed at it from a close-up source. On two side walls of the foil-lined room, I installed steel plates which could be chilled by fluid circulated from an outside compressor unit. The air in this room was kept hot and moist at all times (93° F. and 70 per cent. saturated) by means of an automatic conditioning unit. In another foil-lined room, arrangements were made to chill the air down to freezing temperatures, with ordinary electric radiant heaters as a source of heat rays.

I found that a person could be quite comfortable in the tropical moist heat of the hot room when he lost body heat solely by radiation to the cold plates—either directly or by reflection from the foil wall surfaces. With all the cold plates in operation, loss of body heat was so rapid that actual chilling resulted if a person sat quietly reading for an hour. Rats and mice grew just as rapidly, and with as high vitality, as in the 65° F. air of my ordinary cold room. An assistant, in caring for the animals, found that she needed a sweater to keep from being chilled—and this in air at 93° F.!

Metal cages, wooden objects, and clothing in this hot room were cooled by radiation of their heat to the cold plates, while all foil surfaces remained at the 93° air temperature. A person's clothing thus became several degrees cooler than the air immediately in contact with it. This is a result difficult to imagine, but it actually occurred. As one entered from severe outside summer heat, no immediate difference was noticed; but within a few minutes a feeling of cool comfort developed as clothing temperatures dropped and more rapid loss of body heat became possible. No shock whatever was experienced on passing from the room's comfort into outside heat, for air conditions were approximately the same inside and out. Here was adequate summer comfort without air cooling and the shock and hazards it brings to those entering or leaving the conditioned confines.

In the other foil-lined room, radiant heat furnished delightful shirt-sleeve comfort while air temperatures remained near freezing. A pleasing phase of this set-up was that one had cold air to breathe while the remainder of the body was properly warm. By sufficiently increasing the input of radiant heat (still keeping air temperatures low) a person would find himself perspiring freely while surrounded by cool air. Under such excessive radiant heat load, animals showed the same slow growth and lowered vitality as in ordinary tropical moist heat.

Reflective radiant conditioning, effectively demonstrated in my experimental chambers, offers alluring advantages for both winter and summer use. In the first place it removes the necessity of setting up sharp differences between air conditions indoors and out; this was the particular point I had hoped to achieve because of its health implications. Another very definite advantage is the marked reduction in power load needed either for winter heating or for summer cooling. Different engineers and architects have estimated that the fuel or power load would be reduced 60-80 per cent., since little is wasted in warming or cooling the air mass or wall materials. Such reduction would bring conditions easily within the gas or electric field, thus doing away entirely with the home use of coal and all the resulting smoke nuisances.

Another benefit of reflective radiant conditioning would be its saving in insulation costs. Since the reflective foil surfaces remain cold in winter air and hot in summer—at practically the same temperatures as those of the outside air—heat transfer through the wall would be small. In addition, the foil surface radiates on into the room very little of the heat which comes to it through the wall. Thus, the surface is highly reflective for rays striking its surface, but has almost no power to emit heat which may actually be in the foil itself. In this conditioning system the walls need be constructed to turn wind and rain, but with little consideration for heat-transfer values. This is sharply different from the expensive insulation needed for efficient air conditioning.

One installation of reflective radiant conditioning has been made under actual field conditions. This was in an operating room of a large hospital where surgeons and nurses enjoyed delightful comfort even while midsummer air temperatures in the room remained above 90° F. Certain further developments are needed, however, before this type of indoor conditioning can come into wide use. Means of decorating the foil surfaces must be found, for few people will be willing to have shiny walls in their homes; but such decoration must not interfere with the foil's mirror-like reflectivity. Scientists must develop paints which are heat-transparent in thin coatings. Certain lacquers can be used safely on the foil surface, but pigments must be found to put colour into a room. Finally, the system calls for a heat-transparent plastic to protect the heating and cooling plates from room air, since in radiant conditioning it is desired to leave air tempertaures as little changed as possible. One material already in use has been found to be about 50 per cent. transparent to heat rays (that is, it allows about half the heat rays striking it to pass through), and careful search in plastic laboratories will probably yield another of the desired efficiency. With such sealing-in of the plates, the only heat entering or leaving the room will be that in a radiant form.

A housing research unit in the engineering college of another university is at present equipping a small cottage for radiant conditioning along the lines followed in my experimental chambers, with a conventional air-conditioning system in an adjoining companion cottage. There comparative operating costs and working efficiency will be studied under actual field conditions, and the method made ready for practical application.

It has been quite definitely shown that skin sensations of heat or cold depend upon the rate of heat gain or loss and not on the manner in which the heat arrives or departs. Air, clothing, or other materials feel hot or cold according to the rate at which they conduct heat to or from the skin by direct contact. But radiant heat from a distant source—such as the sun—also feels warm because it too adds to the skin's heat. These principles explain why one can feel cool at 93° F. In my foil-lined hot room, with the air kept at 93° F., a distinct sensation of cold can be obtained by holding the palm of the hand out in front of the cold plate. Even though the hand be entirely surrounded by hot, moist air, the radiant heat loss from the skin to the cool plate causes a definitely chilly feeling on the palm. It seems to matter little to the body through what avenue its heat is lost, just so the total rate of loss be adequate.

Of course, air conditioning is not concerned solely with heating or cooling of the air, but heat control does constitute its major concern. Humidity changes and air motion are only secondary factors to facilitate the warming or cooling effect upon the body. Cleansing or filtration of the air, however, is another separate and important part of air conditioning, one which is greatly needed in the dirty atmosphere of our industrial cities. Other air-conditioning gadgets of limited application are the ozonizers and sterilizing lights now being installed in many places. Sterilizing curtains of ultra-violet light have been found especially useful in hospitals to prevent the carrying of disease germs from one patient to another by air currents.

Still another proper function of air conditioning is the supplying of fresh air to the room. No one yet knows just what the difference is between fresh and stale air except that one is pleasant to breathe and the other is disagreeable. Certainly staleness is not an oxygen lack, nor need it be concerned with an accumulation of body odours.

Staleness of air has been thought by some to be related to the degree of oxygen ionization. Ordinary outdoor oxygen exists in several different forms—as O_2, O_3, and O_4. Its reactivity increases sharply the greater the number of atoms there are associated together. Ozone is presumed to be O_4 and is the most active form of oxygen known. "Stale" air at once becomes "fresh" when passed through a proper ionizing chamber to reactivate its oxygen. Temperature plays an important part in this ionization, for the active forms go back into the inactive more readily when the temperature is high. One of the quickest ways to make room air lifeless and undesirable for breathing is to pass it over hot metal surfaces, as is done in many warm-air heating plants. Room air thus tends to retain its freshness much better if it is kept cool. Radiant conditioning offers a distinct advantage here, for indoor winter air can be kept cold and fresh much more readily when the room occupants are being warmed by radiant heat. In fact, windows could be kept open in midwinter provided no noticeable draughts were present.

Filtration or proper cleansing of outside air as it is taken into a room prevents dirt accumulation both in human air passages and on room furnishings. Such cleansing is badly needed in industrial or densely built-up urban regions. Many people carefully filter all the air taken in during the day but throw their bedroom windows wide open at night, when the outdoor air is foulest. The housewife can see her window curtains disintegrate where the night air strikes them, yet she seldom considers that the foul air may exert a similar corrosive action on the tissues of her respiratory tract. During winter nights, when the "smog" hangs thick over a city, one's nasal linings become heavily coated with the black soot and ash mixture coming from the neighbourhood chimneys—unless, perchance, the incoming air is filtered at night as well as through the day. Our handkerchiefs usually tell the story with their first morning use.

In homes equipped with warm-air heating systems, which include a fan to circulate the air through the house, the windows should be kept shut both night and day during the winter season; then all incoming air is properly cleansed. Bedroom temperatures should be lowered during sleeping hours, it is true, for people usually sleep best when they have cool air to breathe. But it seems inadvisable to allow all the city's flue products free access to your bed-chamber in order to have a night supply of cool air. Americans have greatly overdone the fresh-air idea, anyway, particularly with respect to the wide-open bedroom windows. Ten degrees of night-time cooling should be ample, whereas many of us during the winter sleep in air thirty to fifty degrees colder than we breathe through the day.

Many people consider summer cooling prohibitive in cost, but it is no more expensive than winter heating. The difference lies in the fact that winter heating is essential while summer cooling is more or less a luxury. Hot-weather comfort is particularly costly in tropical climates, where the cooling load is heavy and electric rates are high. Radiant conditioning will be especially appropriate there, both on the basis of its lower power requirement and because it avoids contrasts between indoor and outside air.

While proper conditioning of man's indoor habitat may add greatly to his comfort and health, it is questionable whether it can go far toward overcoming the more profound effects of given climates upon whole masses of people. The lucky few will always enjoy efficient conditioning, but only the poorest makeshift arrangements must suffice for the unfortunate many. Even with all the wealth and mechanical productivity of America, indoor conditioning is still rudimentary in the great majority of households.

In case you plan to join the lucky few, be sure your job is well engineered for your particular needs. Accustom yourself to temperatures around 70°–72° F.; if any members of the household are chilly at these temperatures, have them wear warmer clothing. Overheating is just as harmful for some as chilling is for others. Bare arms or legs are quite often responsible for complaints. Women produce less heat than men and usually chill more easily; so they should be the ones to wear the heavier clothing indoors. Where both sexes live or work together indoors, the men should be in shirt sleeves or wearing only a light jacket, and the women should put on work coats as warm as they need for comfort. Many offices and homes are kept far too warm simply because some occupant would rather complain than put on more clothing. Granny should have her warm corner and shawl while the youngsters do their homework off in a cool study.

Classrooms at school should be made comfortable for the children rather than the teacher. Being older and less active, the teacher usually desires higher room temperatures; however, her needs should be met by additional clothing rather than by keeping the room too warm for the children. In school buildings with central heating and thermostatic control it is probably wisest to keep temperature regulation out of the teacher's hands.

People with chronic rheumatic or sinus infection are always extra-sensitive to chilling. They chill at temperatures quite comfortable for normal persons, but this chilling is just as bad for them as real cold would be. The best solution to their problem is warmer clothing. Except in hospitals and sick-rooms, temperatures should be adapted to the comfort of the normal well people rather than to the complaining few.

By making indoor atmospheres more uniform and stable, air-conditioning engineers have added greatly to our comfort. Progress toward reflective radiant conditioning in the years ahead may allow us to hold these gains and add to them other notable advances. I predict that some day we shall see interior conditioning done largely by radiant means, with a health betterment and cost saving which will make us wonder why we struggled so long trying to do the job through heating or cooling of room air.

But, as we mentioned at the beginning of this chapter, air conditioning is merely a drop in the bucket when the small and isolated spots of man-made comfort are compared with the vast realms of space where climatic forces work supremely indifferent to man. The first five chapters have shown how these forces affect people in the tropics; the following chapters emphasized the driving force and health toll of energizing cooler climates. In the final part of this book we shall look at the larger effects of climate and weather on mankind in general. People who still think of man as a builder of his own destiny will not like what we see.

PART III

CHAPTER 16

LIFE, SUNSPOTS, AND THE ATMOSPHERE

THE EARTH IS SURROUNDED by an atmospheric cloak which may seem filmy and intangible, but actually is so large that it weighs an estimated 5,000,000,000,000,000 (five quadrillion) tons. Even in an ordinary room there are roughly 200 pounds of air. It is within this vast expanse of air enveloping the earth that disturbances take place which cause short-cycle weather changes and the slower undulations of unseasonable warmth and cold occurring every few years. It is this airy sheath which provides the oxygen necessary for life, but within its environs our very existence hangs by the most slender threads of cosmic circumstance.

In fact, the earth is lucky to have any atmosphere at all. Mercury, the smallest of the planets, has none because her gravitational attraction is too small to hold a vast envelope of atmospheric particles and prevent them from wandering off into outer space. Mars, which is about one-quarter the earth's size, probably has just enough water vapour and oxygen to support simple forms of vegetation, but not mammals like those found on earth. Although Venus is slightly larger than Mars, its cloudy atmosphere is mostly carbon dioxide, the gas which you exhale and which bubbles up in soda-pop and other carbonated beverages. Jupiter, Saturn, and the other outer planets cannot support the life we know because their temperatures are hundreds of degrees below zero, and their atmospheres are dense with hydrogen, methane, ammonia, and other unusable gases.

The earth's heavy, solid core, combined with adequate size, gives our planet sufficient force of gravity to hold its atmosphere in place. Even so, only the lower layers of air are dense enough to support life. A mere 6 or 7 miles away from the earth's surface the atmosphere becomes too thin to supply our oxygen needs. Most people are affected even by riding in an aeroplane at the usual flight altitude of 2 miles. At 3½ miles the air is about half as dense as at sea level. From there on out for the next 5 miles it is called "stratosphere" and is inhabitable by man only if he takes along an additional supply of oxygen to breathe.

We are limited in a downward direction also, for life becomes difficult in the dense air 1-1½ miles below the surface in deep mines. Serious troubles often arise on ascending from such mines to surface air conditions. Workers coming up from the deep South African gold mines take an hour or so for the trip, being held for several minutes at different levels to allow gradual reduction in the amount of air dissolved in the blood. Too sudden an ascent causes bubbles of gas to be liberated in the blood; these bring on the "bends" by obstructing blood flow in the smaller vessels and may produce serious damage.

Under-water workers encounter similar limitations and difficulties since the pressure of their air supply must be doubled for each 32 feet of depth beneath the water's surface. For really deep descents into the ocean, such as William Beebe makes for his observations of deep-sea life, sealed chambers capable of withstanding great pressures are used, with surface atmospheric conditions maintained for the occupants.

Not only is human life confined to a narrow layer of the earth's unique atmosphere, but slight alterations in the composition of the air would mean death to all living organisms. We see the fish in our rivers die as we pollute the watery surroundings in which they live, but we seldom stop to consider some of the ways in which our own atmospheric sea might change disastrously. The air we breathe is 78·03 per cent. nitrogen and 20·99 per cent. oxygen; sudden disappearance of the latter element would of course result in the death of every land animal in a matter of minutes. But the atmosphere also contains other chemicals in such tiny quantities that it is difficult to realize their extremely vital importance. There is only about 0·03 per cent. of carbon dioxide in the air, yet elimination of even this small proportion would start a vicious cycle indeed. Plants, lacking this compound, which is necessary for their existence, would wither away and die. Herbivorous animals would soon starve to death, as would man and other meat-eaters. According to animal experiments by Professor J. Willard Hershey and Charles Wagoner of McPherson College in Kansas, the rare gas, xenon, is necessary to life—yet there are only six parts of this element to 100,000 parts of air!

Even with this fortunate atmosphere, however, life could not exist without certain other natural coincidences. For example, during heat waves we look forward to some relief after sundown when the day's heat radiates off into outer space; but what if the earth rotated more slowly—or not at all—on its axis? Mercury and the moon have no such rotation, and their long daytime of accumulating sun's heat results in temperatures far too high for any form of life. During their prolonged nights all this heat is lost into space, and congealing frigidity prevails. So you can see the intricate set of fortunate cosmic circumstances lying behind the existence you so thoughtlessly enjoy day after day.

The terrestrial atmosphere which acts as a vast stage for weather and seasonal changes is also a protection against radiations from outer space. High-energy cosmic rays and ultra-violet rays beat down toward the earth but lose much of their force as they batter against molecules in the great sheathing layers of air. If these layers were less dense, cosmic rays might be deadly for man and other forms of life, while ultra-violet beams would burn all things to a crisp. But the atmosphere allows just enough of these radiations to come through and benefit man. The ultra-violet beams which pass down to the earth's surface promote tissue health and kill germs, while penetrating cosmic rays produce another desired effect.

As these radiations cleave through the upper air, they are thought to impart their energy to its molecules and give it the ionic character which we find so stimulating for breathing purposes. Only in the cooler latitudes of the earth, however, does man get a chance to breathe air from these activated outer layers. Tropical air is usually spiraling upwards, with no compensating down currents from the upper atmosphere. Incoming currents there travel along the earth's surface from temperate regions as the trade winds. In cooler latitudes, however, the activated upper air is frequently brought down to us as enormous masses of cold, heavy air—the "highs"—which sweep across the continent providing clear cool weather and an atmosphere which is often like a heady wine to breathe.

The cosmic rays may thus play an important part in our lives by this effect upon the air we breathe. Perhaps the better supply of this ionized atmosphere in temperate regions is a factor in the greater vigour people of such lands enjoy. The rays themselves also penetrate to the earth's surface more in middle temperate latitudes than farther toward Equator or poles. Our knowledge of their effects is still very sketchy, however; perhaps some day their importance will be better understood, just as we are to-day coming to appreciate the role air temperatures play. Perhaps, too, a sudden increase in their intensity may some day turn them into real death-rays for all life on earth.

Another type of radiation striking the earth's atmosphere is responsible for the day-to-day and year-to-year changes which make up world weather and affect human beings in the many ways described in the previous chapters. Strangely enough, our weather here on earth is strongly influenced by "weather" on the greatest body in our planetary system—the sun—for the sunspots you have been hearing so much about definitely influence our surroundings and are very like our major storms on earth. They are whirling in character, originate mainly in the higher latitudes of the sun's surface and travel eastward and down toward the Equator in much the same way our temperate-zone storms migrate across North America. They may be 100,000 miles in diameter instead of 2,000, but the sun's diameter is about 100 times that of the earth. From their centre gases spiral far outward from the sun's surface, just as the earth's surface air is propelled many miles upward in the centre of our large cyclonic storms. Heat and electro-magnetic radiations stream outward from the dark craters. These are the rays which so seriously disrupt our long-distance telephone, telegraph, and radio communication. Such disruption is now rather expected with each new outburst. Those "highs" and "lows" discussed in the chapter about barometric pressures then come along at closer intervals, bringing more violent changes and colder weather to the temperate regions of the earth.

Sunspots large enough to be seen with the naked eye are present only at or near the crest of the eleven-year cycle, as in the years 1937 and 1938. They are much less frequently seen now (1942), and will almost disappear through the next year or two. They were described in early Chinese writings as well as by ancient Mediterranean observers. For the last two centuries fairly accurate records have been kept of their size and number from day to day. These records show recurring variations from intense sunspot activity down to almost complete quiescence, with the time from one crest to the next varying from eight to sixteen years. An average length of slightly over eleven years has caused them to be called eleven-year sunspot cycles, although none of them has actually been of this length.

If you yourself have never seen these spots, you should watch the rising and setting sun at times when fresh outbursts are being mentioned in the news dispatches. One clear morning in mid-October of 1938, while watching a beautiful sunrise, I was greatly surprised to observe a pair of large dark spots on the otherwise bright-red disc of the sun's face. Only after watching for several minutes to be sure they kept their position on the rising sun was I certain they were not solid objects in our own atmosphere. On each succeeding morning the spots were seen more to the right on the sun's face as it rotated on its axis, and about a week later they had passed around out of sight. The succeeding issue of *Science News Letter* carried a photograph of the pair as its cover design, with a news note about their appearance on an inside page.

Although earth storminess seems dependent to a considerable degree upon sunspot activity, it has been found that the sunspots themselves are in turn dominated by the planets of the solar system as they revolve around the sun. Curiously enough, this influence of the planets was first observed for the earth itself. Mrs. Maunder, the wife of a British astronomer at the Greenwich Observatory, in 1889 observed that the spots increased and were more numerous on the face of the sun away from the earth, while on that portion toward us they diminished in size and number.

Every layman at once wonders how Mrs. Maunder could know what was happening around on the invisible face of the sun, but the answer is simple. She did *not* use a rocket ship for a trip out into space in order to view the other face of the sun! The sun rotates on its axis just as the earth does, except that it takes 28 of our days for one complete rotation. Mrs. Maunder simply kept daily count of the spots in each segment of the sun, and noted that sunspot activity decreased steadily during the 14 days any area was visible from the earth. Furthermore, she found more spots on the surface just coming into view on the left than on that disappearing from view to the right.

Other astronomers have verified Mrs. Maunder's findings and have shown that the same effect is exerted by other planets. Sunspot numbers decline roughly 15 per cent. during the 14 days a given area of the sun is visible from the earth and approximately 22 per cent. while it is exposed to Venus. Venus is somewhat smaller than the earth, but it is nearer the sun and exerts a gravitational force about half again as great as that of the earth. These tidal effects of the planets upon the sun are far from simple, however, and astronomers have not yet been able to unravel them sufficiently to make accurate forecasts of future activity.

It was Dr. Abbot, of the Smithsonian Institution in Washington, who pointed out the direct connection of sunspot activity to earth temperatures. Over a considerable number of years, he found that Washington temperatures tended strongly to be lower for the two weeks after each new outburst than for the fortnight preceding. I myself studied temperature records back through the last two centuries in Europe and America, and found that unseasonable cold prevailed in two-thirds of the months during years of rising or high activity; during years when the sunspots were declining or low, two-thirds of the months were unseasonably warm.

The amount of heat given off by the sun is greater when the sunspot activity is high, and yet earth temperatures fall in middle latitudes. This is explained as being due to the more active convection currents set up in our surface atmosphere at such times by the more intense sun's heat, particularly in equatorial regions where the heat rays strike most directly. The convection currents are supposed to pass outward toward the poles at high altitudes and return to the earth's surface as the polar cold waves which bring increased storminess and lower temperatures to temperate-zone lands. Whether or not this explanation is correct, it is true that greater sunspot activity does tend to bring cold and storms to middle temperate regions. During periods of low sunspot activity the weather is more likely to be calm and unseasonably warm.

When these periods of exceptional "summer" warmth and calm come over the earth, northerners tend to take life at an easier pace. The result, when brought out by careful statistics, is a vivid example of how man is under the influence of outside forces, for with the decreased energy men pursue their business lives less actively, are less disposed to put forth the effort needed to support non-essential expenditures, and in every way take life at an easier pace. Wall Street and other financial centres feel the passive impact of this rhythm during warm periods of low sunspot activity and, consequently, such periods are often accompanied by severe depressions. Heat was present with the panic of 1857, during the gloomy "seventies," and with the breaks of 1893, 1907, 1920, and 1929. Our security panic of 1929 occurred a month before the temperatures here began their prolonged elevation, but severe unseasonable warmth had already struck Europe four months previously.

Practically every prosperity or boom period, on the other hand, has been a time of normal or low temperatures. Such was the stimulating weather preceding the nation's past crashes. For the last three years of the first World War unseasonable cold largely prevailed in America, giving a firm basis for the remarkable expansion in our wartime industrial output. Temperature conditions were not quite so propitious for production early in the present war, for we had been held down by protracted warmth most of the time since late 1929. But there were subnormal temperatures generally in 1940 for the first time in over a decade, and in that year our industrial machine seemed to shake off its ten-year collection of cobwebs and oil up for intensive action. Moderate warmth in 1941 slowed it down somewhat, but in the first half of 1942 optimal temperatures have prevailed and allowed our war production to reach really amazing levels.

Although the medical profession feels the result of these weather changes especially strongly, the average physician seldom realizes how closely temperatures, business activity, and health are interrelated. When times are hard, he blames his reduced income on the assumption that fewer potential patients make calls because they, too, are earning less money and cannot afford medical service. But the facts invalidate this easy assumption, for general death rates are lowest during those same depression years when there are fewer calls for a doctor's help. The medical profession need not worry, however, for it does *not* follow that visits to the family physician actually increase the risk of death! The high temperatures which accompany low sunspot activity and influence financial depressions also bring reduced storminess, greater relaxation—and the human machine works under lower stress.

During these warm periods respiratory attacks and other acute infections strike less frequently. Heart failure cases entering the Cincinnati General Hospital—considering only those unassociated with bacterial disease—were only a quarter as numerous through the very warm years from 1929 to 1933 as they were before or afterwards. Normally such cases are four times more common in winter than in summer, but during those balmy winters low summer rates prevailed. Toxic goitre cases also became more scarce. Quite regularly back through past depressions in America illnesses and deaths have been reduced as business activity lessened. Health authorities have always predicted dire consequences from the smaller expenditures for health purposes during such hard times, but no such ill effects ever occur. The health improvement always lasts until the people again become involved in another rising tide of business activity. Hard times severely affect the country's doctors, for collections are poor and fewer calls are made upon them. During prosperity their services are in greater demand to stem the rising sickness and death rates.

Tuberculosis is one of the diseases showing great improvement in times of depression, and it is the one which health workers always expect to become worse because of increasing poverty and malnutrition. It benefits greatly, however, from the reduced storminess and lessened acute respiratory illnesses of the warm years. The long decline in its death rate is usually accelerated most during prolonged economic recessions and sometimes receives a temporary setback with the return of the colder and more stormy years of better times. Solution of the mysteries of sunspot and other outside controls over earth's weather would probably go far toward removing the disastrous effects of these recurring economic cycles which beset us.

I do not mean to infer that weather is the only factor at work. Wars, mass migrations, changes in population pressure, over-expansion of production—these are also extremely important elements in setting the stage and determining the intensity of the reaction once it starts. It is weather, however, which affects the energy background in man himself, deciding whether he shall be energetic and expansive in his planning or whether fear and inaction shall prevail.

All the evidence of this chapter emphasizes the intricate meshing of environmental factors which makes human life what it is. It could not exist unless the earth had been able to hold an atmosphere, unless the earth were tilted on its axis at just the right angle. Variations in atmospheric composition, some of them extremely small, would kill man and all his fellow creatures, while the air itself is just dense enough to protect people from the potentially lethal radiations of outer space. The earth's great blanket is under continuous bombardment by these radiations, as well as by the radiations resulting from sunspots, and their effect plays an important role in the weather which in turn affects man's activity and health. Since the sunspots themselves seem largely controlled by the positions of the planets, life—and more particularly human life—is seen to be part of a vast organic unit, a unit which includes at least the entire solar system. Whether celestial bodies outside our own tiny system also influence our lives has not yet been studied, but this possibility cannot be excluded.

Without subscribing to the unfounded tenets of astrology, which hold that the detailed events of every person's life are pre-ordained by the positions of planets at his birth, we now have a scientifically discovered and direct chain of influences meshing our daily lives into the larger forces of our own solar universe. The chain cannot be over-emphasized; the planets in their shifting positions around the sun cause the sunspots to wax and wane. As a result there arise variations in solar radiations to the earth and changes in temperature and storminess. These weather changes, both short-cycle and over longer periods, markedly influence our body functioning.

CHAPTER 17

ICE AGES AND CLIMATES OF THE FUTURE

SHORT-CYCLE WEATHER CHANGES and the slower alternations of unseasonable warmth and cold every few years are rather well explained on the basis of solar-system forces. Our knowledge is inadequate, however, to explain other changes extending through the centuries or covering thousands of years. Most definite of all climatic fluctuations were the slow undulations from one ice age to another. In the most recent of these the North Polar ice cap spread down over North America as far as the present courses of the Missouri and Ohio Rivers. These rivers were raging torrents as they carried away the melting ice and snow from the ice cap's fringe. The Ohio River cut several different channels for itself here at Cincinnati as the glacier edge alternately advanced and receded through that era.

Several times these ice ages have returned to the earth, causing polar cold to prevail far down into what are now temperate regions and compressing the tropics into a much narrower belt. In the intervening warm periods tropical warmth has expanded outward toward the poles and the ice caps may have completely disappeared. It is estimated that only about 30,000 years have elapsed since the last ice age was at its crest. Where Cincinnati now sits, with its mild winters and hot summers, was then a grinding, crackling glacier front with a climate similar to that of southern Greenland to-day.

Although men were present here on earth long before the last ice age, their numbers were small and there is little evidence from which to construct a story of their activities. Since humanity has actually stepped out of the shadows only within the last 10,000 years, we can devote chief attention to climatic fluctuations within that period. They have been present, but in a much less drastic form than the changes from ice age to inter-glacial warmth. Evidence left by receding ice caps and glaciers, by silt deposits along rivers fed from melting ice, by salt layers along inland lakes, by the growth rings of our giant redwoods in the South-west—all these and information gleaned from recorded history point to several prolonged cold periods alternating with centuries of warmth.

Through the last 10,000 years these slow undulations have occurred with fair regularity, the glaciers and ice caps receding rapidly for a thousand years or so and then halting or even advancing somewhat for the next thousand. It was this stair-step recession which left the long moraines of piled-up gravel and boulders at intervals over the course of the receding ice cap here in America. To-day the last ice age is represented only by isolated mountain glaciers and by the small ice sheets covering most of Greenland and Antarctica. Another cycle or two of recurring warmth may well cause their complete disappearance.

The last millennium of warmth fell within the time of recorded history, covering the Dark Age period from the fall of Rome to the Renaissance (from the fifth to the fifteenth centuries A.D.). During this warmth cereal grains were regularly grown and ripened in Iceland and wine-making was carried on in parts of Great Britain where it has not been possible to ripen grapes through the succeeding centuries. The shores of Iceland were largely free of ice packs for the first several hundred years after its settlement, but since the fourteenth century its northern shore has again been icebound and its climate has become too rigorous for crop raising.

The climate of Greenland in the ninth and tenth centuries, when the Norse settlements flourished there, apparently differed from the climate of more recent times. Early in the eleventh century, however, the colonies rapidly declined, with increasing evidence of rickets in the skeletons of those buried during the settlements' decline. The dead were buried deep in the unfrozen earth during the ninth and tenth centuries, but after that the graves gradually became shallower as the summer thaws penetrated less deeply.

Many of those Norse bodies in Greenland were found almost perfectly preserved when rising world temperatures had again thawed out the earth to make their excavation possible a few years ago. Recent excavations in earth which had been solidly frozen for almost a thousand years have given us a glimpse of those settlements as they declined in the oncoming cold. In that ancient warmth the people carried on extensive cattle-raising—

an activity quite impossible in the Greenland of more recent times.

The scanty records indicate terrible winters of snow and ice in northern Europe preceding the Dark Age warmth, while the civilizations of early Greece and Rome were flourishing in regions which are now too enervating for sustained effort. Egyptian writings of those centuries tell about winds and storms which can only mean that the cyclonic storms to-day travelling eastward over Central Europe then passed down the Mediterranean Basin and on across Asia Minor. Palestine and the other eastern Mediterranean countries had a more copious rainfall, better distributed through the year, than has been the case in modern times.

The heat of the Dark Ages was at its worst about A.D. 850. By A.D. 1000 there were evidences in Greenland of returning cold, and by A.D. 1400 the ice packs had again closed in on northern Iceland. Through the centuries since the time of the Renaissance and the revival of learning, cold has largely prevailed. Actual thermometer records go back only two hundred years, but within that time they show lowest temperatures to have occurred around 1850, about a thousand years after the peak of Dark Age heat.

What about the trends of modern times? The records definitely show that temperatures over the earth have been rising almost universally for the last eighty years or so, slowly at first but much more rapidly in recent years and especially during the last twenty years. Climates have indeed altered since Grandfather's day. The winters are milder and the summers hotter. My father in his later years often mentioned the rigours of his boyhood winters, contrasting them with the milder temperatures of the twenties and early thirties before his death in 1933. Even in my own childhood and youth the silky crunch of subzero snow was encountered many times each winter, whereas now the blankets of snow are wet and sloshy.

Up until very recent years everyone ridiculed the idea of climatic change. It was claimed that people in later life would remember more vividly the extremely cold spells, but forget the milder winters which had failed to leave so strong an imprint. False impressions of this kind are known to be fostered by such tricks of memory, so the matter was always treated as a joke. Ellsworth Huntington and certain other investigators had great difficulty getting even scientific people to believe their evidence of past fluctuations. Meteorologists, however, finally began examining world temperature records of past decades.

The facts revealed by such examination quickly dissipated all opposition, for they showed beyond doubt that the winters ot Grandfather's day really were colder; mean temperatures were lower and the cold waves more severe and frequent. The temperature rise is by no means a steady, even one; wide changes occur with the eleven-year sunspot cycles. But the cold phase of each succeeding cycle is a little less cold, and each warm phase is a little warmer.

When we consider what this rise means to us, we come face to face with a situation emphasized in the last chapter: Man exists solely because of a fortunate balance of chemical and physical factors in his environment. A mere 10° F. rise in tropical temperatures would make life practically impossible for him and all other warm-blooded animals whenever humidity accompanied the heat. In my experimental hot room I have found 90°–91° F., with 60 per cent. water saturation of the air, to be the highest level at which warm-blooded animals can live without a sharp rise in death rate and complete loss of reproductive capacity. On several occasions the electric controls have failed to operate and temperatures of 97°–98° F. have wiped out my whole hot-room animal colony within a few hours.

Severe summer heat waves sometimes leave us with an exceedingly narrow margin of safety even here in middle temperate America. When heatstroke cases begin to appear in the hospital, a rise of another 5° F. in air temperatures would produce a holocaust of deaths. In the summer of 1934, Death had whole population masses almost within his grasp as temperatures in middle United States latitudes soared past the 100° F. level for the daytime maximum. Cattle, horses, hogs, dogs, birds—all were dying or endangered along with man.

While a rise of 10° F. in earth temperatures would render the tropical lowlands uninhabitable, a fall of 10° F. below present levels would bring on another ice age and bury large continental areas under miles of snow and ice. This happened several times in the past, blotting out whole species of animal life. Humanity was then scarce and even in the most propitious climates led a furtive existence of exposure to the elements. To-day mankind is numerous and has encroached into the regions of climatic extremes where existence is sorely handicapped. Severe climatic change might well wipe man out in such marginal zones. Not so many thousands of years ago polar cold congealed American life well below the Ohio and Missouri river latitudes, for these rivers marked the southern boundary of the ice sheet. It is difficult indeed to imagine Kentucky with Greenland's icy cold, but such was then the case.

Man's chief enemies—aside from his own fellow men—are the innumerable hosts of bacteria and other micro-organisms lurking everywhere around him. Many bacteria are friendly, performing functions essential for our welfare. The unfriendly ones are largely those which reproduce and do best at or near body temperature (98° F.); they thus thrive best in the tropical moist heat which is most depressive to our own tissue vitality. Any considerable rise in earth temperatures would thus also upset the balance between us and our bacterial foes, increasing their advantages in the struggle. Conditions would become more propitious for their growth in food and water outside the body, while our resistance to their invasive attacks would be still further weakened. Eventual elimination of the human race may well take place through the attacks of these swarming billions of microscopic invaders.

A rise in earth temperatures and further outward expansion of the broad belt of tropical heat would also bring still another increase in human handicaps. As the B vitamin requirement is so much higher in tropical heat, we would need a food supply richer in these elements; but meat animals grow poorly in the heat and yield meat deficient in these vitamin catalysts. The cereal grains, our other important B vitamin source, also do poorly in hot climates. So here would be an additional devitalizing factor pulling man down in a world of even moderately rising temperatures.

Of course, a 10° F. change is not likely to occur universally, but the dangers of such a change will probably exist to a smaller degree as the earth's temperatures slowly rise. It has been estimated that a rise of only 2° F. in over-all earth temperatures would clear the polar seas of all ice and raise the oceans' level about 150 feet. Dr. Arthur P. Coleman of the Royal Ontario Museum in Toronto has drawn a vivid word painting of the result: "With a little imagination, one can picture Oslo or Rio de Janeiro, seaports with high ground in the rear to which to retreat, as sending palatial holiday cruisers to see New York's deserted skyscrapers rising as steep-walled bird rocks from a shallow sea

Real-estate owners need not worry for the time being, for this is still a possibility of the distant future. Temperature rises of two degrees and more have occurred in restricted regions of the earth but, luckily for us, not for the entire globe as a whole. Still, these changes in temperatures and in storminess are producing noticeable effects to-day. They result in marked alterations in inland rainfall. On the western plains of America, for instance, deep low-pressure storm centres are needed if moisture is to be carried that far inland by air currents from the Gulf of Mexico and Atlantic Ocean. Periods of heat and lessened storminess therefore mean an expansion of our desert areas in the South-west. Early settlers on the plains tell of the grass being stirrup-high even as late as the middle of the last century; to-day the crop is scanty and short. Much of this change may have been due to over-grazing, but reduced rainfall and more severe summer heat have also played a large part.

As I drove from Kansas up through Nebraska and South Dakota in July of 1934, swirling dust clouds obscured the sun and nearby landscape, and shifting topsoil buried fences, buildings, and roads under ever-changing drifts. There I saw deserts in the making—it was truly a gruesome sight. The soil of Kansas shows that the plains experienced similar periods of long-continued drought and blowing topsoil centuries before there was any cultivation or over-grazing upon which to lay the blame. No narrow band of planted trees is likely to halt, or in any way affect, these major shifts in inland climates. They seem linked rather to the changes in world weather taking place under fluctuating outside influences from the solar system.

As earth temperatures rise and cyclonic storminess lessens, rainfall in the southern and eastern sections of the United States will tend to become more sharply seasonal in character. Floods and soil erosion will be accentuated during the rainy season. Drought conditions through the remainder of the year will be much less favourable to agriculture than is the present more even distribution of rainfall. Perhaps our Ohio River flood of 1937 will pale into insignificance as we plunge another century or two into the coming warmth.

Dust storms of northern China have for centuries been carrying loose top soil eastward toward the ocean during the dry winter seasons. In some places enormous banks of this fluffy loess fill whole valleys, constituting the predominant top soil there just as it does in Kansas. During the North China dust storms the sun may be entirely obscured or just faintly visible through the swirling clouds. A sprinkle of rain at such times often showered us with pellets of mud. Dust originating a thousand miles inland was carried hundreds of miles out to sea over the Gulf of Peichili.

Americans berated the Chinese for permitting farming methods which made possible this shifting of top soil. But our own dust storms of recent years have brought home to us the futility of our puny efforts to hold back the mighty forces of Nature. Our fertile plains became an American Dust Bowl, generating clouds of fluffy top soil 1,000–2,000 miles wide which swept eastward across the continent and out over the Atlantic Ocean.

I smiled as I saw these enormous dust storms sweep over Cincinnati, with showers of mud pellets or layers of powdery clay coating everything in sight. We Americans had been so sure of our wisdom as we blamed the Chinese people for their dust storms, floods, and famines. Now they can smile at us as we experience in a minor way the adverse natural forces with which they have been contending for centuries. Intelligent Chinese look upon us as rather raw barbarians, lacking in the refinements of real civilization and much given to telling the other person what he should do for his own good. They hope that another few centuries of living experience may mellow us somewhat and increase our tolerance of the mistakes others make when faced with difficult situations. Until recently in our national history an exuberance of energy and a great wealth of natural resources had enabled us to make good on our boastful and egotistic attitude. Perhaps the climatic changes now apparently brewing will bring to us a degree of wholesome humility.

You need no longer doubt the validity of climatic change. Huntington prefers to call it pulsation rather than change, emphasizing its cyclic character instead of any one-way trend, and he is quite right.

Cyclic fluctuation is the keynote from beginning to end. Shortest of these cycles are day-to-night variations. Next longer are weather changes brought by passing cyclonic storms. Then come the seasonal changes of each year and the more irregular alterations occurring every few years in an indefinite association with the eleven-year sunspot cycle. Marked shiftings covering several centuries have taken place, but the most regularly recurring ones of longer duration have been the 2,000-year cycles of alternating cold and warmth in evidence since the last ice age. Most striking of all, of course, were the alternating ice ages and interglacial warmth.

This climatic habitat in which we live and by which we are so dominated is thus seen to be in a most unstable state. One year we are pushed forward into restless strivings by cold and storms. The next may bring debilitating heat and physical lethargy. Sometimes there are almost as marked differences in the intensity of climatic stimulation from season to season or from one year to another as there are in different regions. A long summer of severe heat in Cincinnati may leave the city's residents with a distinct turn toward tropical characteristics, but a winter of prolonged cold again prods them into energetic activity. Our responsiveness to this fluctuating environment raises several social and economic problems which deserve careful consideration against the background of climatic influence here painted. These will be considered in the following chapters.

CHAPTER 18

CLIMATE, WEATHER, AND WORLD DOMINANCE

STORMY WEATHER HAS BEEN held responsible for many of our respiratory and rheumatic ills; however, atmospheric turbulence has its good points as well as its bad. Frequent change gives a wholesome and stimulating variety to life, inducing in people a restlessness which—when coupled with coolness and a high energy level—drives them on to build skyscrapers, set up great factories, and pursue other energetic activities. There is little monotony, either climatic, mental, or physical, in such surroundings; while certain types of disease may abound, health in general is most buoyant and life most interesting. The men dwelling amid such influences are the ones who have dominated the world in the past and who have left their home countries to build empires in distant lands.

Storms sweeping across Indiana were among the most potent factors influencing my childhood years. To me they represented the real might of Nature as they came from the South-west to darken the entire sky. Excitement and sometimes childish terror accompanied the thunderous tumult of their passing, while deepest awe and exultation came over me as I watched the vivid colouring made by the setting sun against the receding cloud masses. Even as a boy they interested me by their definite pattern of approach and passage. Surely, I thought, only the most supreme and powerful ruler of the universe could keep harmony and order in the presence of such violent, raging forces.

City residents miss much of this closeness with Nature. For them, with attention focused upon crowded humanity and its doings, such disturbances only bring inconvenience and interference with plans. Even the glorious after-colouring in an evening sky often goes unheeded.

As I grew older I learned that various parts of the earth differ greatly in their storminess, that few regions can compare with the middle-west and western plains of America, and that the storms do indeed follow a quite definite pattern. Across temperate lands they travel mainly eastward, with the low-pressure centre preceded and followed by a "high" and cool clear weather. Warm moist winds rush in toward the "low" centre and then spiral upward clockwise, being chilled as they rise and precipitating their moisture upon the earth beneath. Barometric pressure falls and temperatures rise as such low-pressure centres approach a given locality. Those are the weather periods which most disturb body function in men and animals. As they pass on, pressure begins to rise, temperatures fall, the skies clear, and life assumes a more cheerful aspect.

During peacetime many city newspapers printed daily weather maps, recognizing an increased reader interest in weather and the behaviour of the elements. War censorship now prevents the publication of these maps or the broadcasting of extensive weather reports, because such information would be extremely valuable to our enemies in plotting the changes coming their way. Plans for the dash of the German warships *Gneisenau* and *Scharnhorst* from their Brest berth up through the English Channel were no doubt based upon reports sent in from scouting planes and ships out in the Atlantic Ocean. With a period of bad weather and winter fog in the offing, details of the move were worked out in such a way that the English were relatively helpless when they finally spotted the ships through a break in the Channel fog. Swarms of German fighter planes had been held in readiness for air coverage just in case the fog should lift. Accurate prediction depends on a thorough knowledge of world trends in air-mass movements, and the less the Nazis know about such trends around North America, the less accurate will be their timing of strategic moves.

As far as possible, you should familiarize yourself with weather maps, for they are extremely important in your life. Observing them from day to day, you can see the "highs" and "lows" marching across the continent, bringing with them the sharp alterations in weather which give spice and variety to life. Many of the high-pressure centres come down from the Canadian

North-west and turn eastward across the Mississippi Basin at various latitudes, some of them even going down across Oklahoma and Texas to pass out eastward over the Gulf of Mexico. Other "high" centres come in from the Pacific coast at middle latitudes and bring with them less vigorous weather change.

Not all temperate-zone lands are equally affected by these eastward-travelling storms; they are probably most vigorous and reach farthest south in North America. Across Europe they follow a more northerly course, entering mainly across the British Isles and countries of West Central Europe. In both northern and southern hemispheres they are responsible for the storminess of the mariners' "roaring forties," but in the south these latitudes involve relatively small amounts of land surface—only the southern half of Chile and Argentina, the southern fringe of Australia, and all of New Zealand. South Africa is little affected.

Storms entering across Europe seem to be dissipated in the great spaces of Soviet Russia. Siberia has violent weather changes, but its storm tracks have not yet been plotted. In eastern Asia less violent disturbances generate on the highlands of Tibet and Mongolia, then sweep down across China and Japan during the winter season. Everywhere these temperate-zone storms are more frequent and vigorous in winter, penetrating closer to sub-tropical latitudes. In the summer they become fewer, travel more slowly, and follow a more northerly course. In North America this seasonal difference means that the South has stormy weather during the winter, but is blanketed by stagnant moist warmth through the long summer. Even in the North, summer storminess is only half that of the winter.

Another type of disturbance originates over ocean waters in the outer portions of the tropics, largely between latitudes 10° and 20° and particularly in the Indian and western portions of the Atlantic and Pacific Oceans. These are deep low-pressure centres which—and this is important—are not preceded or followed by corresponding "highs" as they travel westward over tropical waters. In the Atlantic they lash the West Indies, Gulf of Mexico, and south-eastern coast of North America, many of them swerving north-eastward up the coast sometimes as far as New England. Here they are known as hurricanes. Over Oriental waters and the Indian Ocean similar disturbances are called typhoons. From the Pacific Ocean they sweep westward across the Philippines, then turn north up the China coast and out north-eastward across Japan. These tropical storms are sharply seasonal, occurring largely from September to December in the northern hemisphere. In the Bay of Bengal they are particularly violent for this brief period each year.

No stimulation attends the passage of such "low" centres, since they are not followed by "highs." Populations lying in their path are wracked by the falling-pressure effects but benefit by no stimulating coolness such as comes in the wake of temperate-zone storms.

Over most large tropical land masses the weather is monotonously even, with never more than a few degrees of temperature change from day to day—or throughout the centuries, for that matter—and with negligible pressure variation. Rains are sharply seasonal; in fact the wet and dry seasons are the only ones spoken of in tropical lands. This type of weather, non-stormy and sharply limited as to rainy season, also extends well outward into certain parts of the temperate zones. It prevails in Mexico and the south-western United States, in the Mediterranean countries of Europe and Africa, and to a considerable degree in much of China.

Considering North America in greater detail, we find that storms are most frequent across the northern half of the United States. Weather changes are most violent on the western plains, with the sharpest and widest fluctuations in pressure and temperature as the storms pass by. Farther east the changes are less abrupt. Daily variations in the maximum and minimum temperature readings throughout the year give sharp emphasis to this greater turbulence at Bismarck as compared with New York City.

Each line on the accompanying storm-track maps indicates the course followed across the continent by a high-pressure centre, but it should be kept in mind that these moving air masses are of enormous size—often 1,500 to 2,000 miles in diameter—so that wide sections of the country are affected on each side of the moving centre. The south-western United States, however, is seldom bothered by the centres sweeping down east of the Rocky Mountains, even during the more turbulent winter season. A few of the winter "high" centres pass down and out over the Gulf of Mexico, bringing freezing weather even to the southern tips of Florida and Texas.

One such "high" swept down over the Gulf of Mexico late in January of 1935 while the ship on which I was Philippine-bound was travelling up the south-western coast of Mexico. As we started across the Gulf of Tehuantepec a terrible gale struck us from the north, buffeting the ship severely for several hours until we reached the western edge of the gulf. The ship's captain explained to me that such gales were frequent in winter, whenever a "high" settled in the Gulf of Mexico. Mountains extend throughout the length of Mexico except in the low-lying Isthmus of Tehuantepec, and over this low isthmus the cold, heavy air of the "high" centre escapes southward to produce gales such as we encountered.

Storms and the variety of weather changes they bring serve as foreground details of the environmental picture, while the more sedate features of climate provide the dominant design and background. We may be pushed this way and that by short-cycle weather changes, with our bodily and mental functions badly disarranged. It is climate, however, which determines the general energy and vitality level upon which we live. Mean temperatures prevailing at different latitudes out from the Equator are of profound importance to man, since they decide the ease with which he can lose his own body heat and hence the rate of combustion allowed in his tissues.

Tropical lowlands everywhere are blanketed by a continuous moist heat which makes an active life impossible. Natives of such regions are sluggish or lazy not as much from choice as from necessity; if allowed greater ease of heat loss, they soon become more active. This was well illustrated by the hundred Philippine women wrapping bubble gum in a Manila factory, who turned out 30 per cent. more work after the manager installed cooling equipment to provide a 65° F. temperature in the wrapping-room.

The tropical blanket of moist heat often extends only two or three thousand feet above the ground, giving way rather sharply to cold upper air. It is in this border that clouds form wherever an upward current carries the moist surface air through into the cold zone. Going aloft in an aeroplane, you suddenly leave the depressing surface heat as you pass above the cloud layer. Tropical upland regions are thus distinctly more stimulating than the lowlands, and the natives readily show the difference by their activity and alertness.

I had not realized just how sharp this contrast might be until an aeroplane trip transported me suddenly from the enervating Manila heat up into the mountain coolness at Baguio. From there I went by car through the Bontoc rice-terrace region and on up to the Igorot country, where, at 7,000 feet, ice occasionally formed at night. Up there the midday sun was warm, but blankets were always needed at night. The natives walked or trotted with quick springy step, were keen-eyed and stockily built as compared with the more slender, slouching residents of the hot lowlands.

According to legend, a large group of lepers had escaped into this mountain region back in early Spanish days and had lost their disease in the more invigorating mountain atmosphere. Whether or not the legend has any basis in fact, it is true that the disease is very much less frequent in the mountain provinces than among the lowland people. Going back down again into the Manila heat, I appreciated more clearly what sharp differences in ease of body heat loss might mean in terms of human energy and vitality. The Manila people now seemed well justified in their praise of the Baguio air.

What such differences mean in military terms was shown in the case of the highland Igorots, who took such vigorous part in the defence of Luzon when the Japanese invaded the Philippines. They were also one of the most powerful groups in carrying on guerrilla warfare and underground activities after Luzon was lost. As the war continues in tropical countries, such peoples will undoubtedly continue to make things as unpleasant as possible for invading armies and they will be able to do so because of the driving forces of their native climates. It was in the high Igorot country that the Filipinos carried out the most active and prolonged resistance to American forces following the Spanish-American War.

Unfortunately, highland regions within the tropics are not extensive or capable of supporting large populations. The Andes Highlands of South America and the Abyssinian Plateau of Africa offer temperate climates amid the morass of tropical heat, and on them man has at times done well. No major storm changes come to disturb their weather, however, or to add spice and variety to life. People living at Bogotá in the northern Andes give glowing accounts of their climate's perfection—never too hot or too cold, always just right—but they also tell of frequent nervous disorders during the long cloudless months of the dry season and of an intense desire for weather change. For them it is often a relief to spend a few weeks down in the lowland heat.

South America is not particularly blessed, climatically speaking, except for the Andes Highland valleys—where ancient Indian civilizations reached such high stages of development before being despoiled by the Spanish conquerors. Only the southern half of Argentina and Chile are favoured by temperate-zone coolness and storms. To be sure, moderate relief from lowland heat is afforded in the Brazilian Highlands along the eastern coast, but throughout the jungles of the Orinoco, Amazon, and upper Paraná basins debilitating heat holds man down to a life of tropical lassitude.

As a whole, Africa is in a similar situation. It has little to recommend it in a climatic sense. Monotonous heat is the dominant factor from Cape Town to Cairo, unrelieved anywhere by major cyclonic storminess. The southern portion is a tableland standing 2,000 to 4,000 feet high with its elevation giving some relief from the heat, but only the southern tip gets much weather effect from the cyclonic storms travelling eastward a few hundred miles farther south. Winter brings comfortable coolness to both southern plateau and northern desert, yet nowhere on the continent are conditions favourable to any great human progressiveness. South Africa is handicapped least, but its climate has little of the invigoration which pushes man forward in central latitudes of North America or in West Central Europe. Through the continent's equatorial jungles human existence is held to the lowest possible level by steaming heat.

In sub-tropical portions of the temperate zones, summer warmth is fully as enervating as in regions nearer the Equator, but a welcome relief is afforded by winter coolness. Life goes on at a more active level during the cooler months, but slumps back into tropical lethargy as summer heat returns.

Man has his best chance to live a highly vital and energetic existence in middle temperate latitudes of the earth. Summer heat is usually brief and interspaced with cool periods, winter cold is not too great, and ideal temperatures are brought by the spring and autumn months. Across North America at latitudes from 35° to 50° these stimulating temperatures push man into an energetic restlessness and a great impatience with the slower life of tropical lands. From Cape Hatteras to the mouth of the St. Lawrence, from Memphis to Winnipeg, and from Los Angeles to Vancouver, human energy and initiative rise to the highest level. Frequent storm changes in the weather and wide seasonal variations leave few dull intervals for Americans of these latitudes.

Best temperatures for man fall farther north in Europe, at latitudes of about 45° to 60°. This is owing to the warming effect of the Gulf Stream as it flows across toward Iceland, and also to the more northerly course of the storms as they travel eastward over the continent between the Alps and southern Scandinavia. Temperatures and storminess in the Mediterranean countries are about on a par with those of our southern states bordering the Gulf of Mexico. Italy has much the same latitude range as New England, but its climate is more like that of Georgia. Most people think of Tunis and Algiers as located in tropical heat—and so they are—but their latitude differs little from that of St. Louis or Washington.

The Mediterranean region receives a moderate number of Atlantic storms during the winter months, but depressive heat rules constantly throughout the long summer just as in our states on the Gulf of Mexico. Across West Central Europe, on the other hand, storms coming in over the Gulf Stream bring frequent weather changes throughout the year, moderating both the heat of summer and the cold of winter. Toward the east of Europe weather changes lessen, while seasonal contrasts are exaggerated; both summer heat and winter cold become more protracted and severe.

Seasonal extremes of heat and cold also occur over most of Central Asia. Cold waves penetrate well down from the frozen northern tundras, but their exit over the plains of India or China is barred by lofty highlands. As a result, cyclonic storminess is low over southern and eastern Asia and the climate is monotonously regular. During the winters we spent in Peking cold dry winds blew outward from the interior for weeks at a time, with the barometer standing constantly high. The winds were reversed through the summer months, as moist tropical air flowed north-westward toward the superheated interior. Those were the summer monsoon winds which lay a blanket of depressing, moist heat over Japan and China every year. Similar monsoon currents also flow up across India during the summer months.

All southern and eastern Asia is thus oppressed by severe summer heat, without cold stormy winters to counterbalance. The result is a human inertia and energy level only slightly better than the tropics permit. A few storms do generate on the high slopes of the Himalayas and highlands of Tibet, following down the Yangtze Valley and out over southern Japan. These help make the upland portions of China's Yangtze Valley one of the most stimulating parts of eastern Asia.

Southern Australia and New Zealand are among the earth's most favoured regions so far as climatic effects directly upon man are concerned. Summer heat and winter cold are moderated by nearby oceans; cyclonic storms bring ample weather variety at all seasons. Health hazards of winter are much less than in the northern United States, where severe cold and the year's most intense storminess bring a sharp peak in respiratory diseases and heart failure. Central Australia, except along the eastern fringe, is very sparsely inhabited; and in the north, tropical heat exerts its typical effects. Man's progress in southern Australia during the last century has been astounding, but the favourable land area is so small that no really large population mass can ever be properly supported. On the streets of London one has difficulty in differentiating the Australians from the Americans or Canadians except by their speech; all have that springy step and keenness of eye found only in people from really invigorating climates.

Truly favourable climates are thus seen to be limited to only a few areas of the earth and to perhaps a third of its human population. North America has the largest and most invigorating of these regions, with West Central Europe a close second. It is probably not by chance that people of these two regions so dominate world affairs. In them energy and initiative run high, combined with a restlessness which is forever seeking new outlets of expression. At the opposite pole of human energetics lie the broad expanses of tropical lowlands. In them another third of the earth's population is held captive by the insurmountable difficulty of losing body heat. This third of mankind seems to exist only for exploitation by the energetic third. In between lie the people of the middle third, living under climates which hold them to a neutral course. China, southern South America, South Africa, and the Mediterranean countries seem destined to pursue a middle course in human affairs. As for Russia and Japan, these nations are at the peak of their military successes—one in holding off and then driving back supposedly invincible Nazi armies, the other in sweeping rapidly throughout the Far East and toward India. But only time can tell whether they will have sufficient climate-given energy to keep up their successes.

The North American and European stimulating areas are also blessed by a wealth of natural resources for man's use in his ceaseless activities. Not content with their home resources, however, these energetic people also reach out to exploit the earth's natural wealth in other regions where the native residents are too listless to do so themselves. World dominance is thus firmly based on the driving force of climate. Were the storms of Central Asia suddenly shifted across the plains of China, the people of that great nation would in all likelihood become more prominent in world affairs, make better use of their own great natural resources, and drive the Japanese out of their country in short order.

CHAPTER 19

THERMOMETERS AND HISTORY

REVOLUTION AND CONQUEST have always been considered to spring from the deep inner urgings of people: in the one case from the desire for freedom from tyranny and in the other from the desire of a few men for power. Such is really the case, but the development and growth of these urgings are linked in a most surprising fashion to the rise and fall of the mercury in thermometers. Stormy cold has driven oppressed people into open revolt time after time, just as enervating heat has had them pliant under the oppressor's heel. Group after group of the world's people have been pushed out on to the roads of conquest and expansion by optimal climatic conditions, only to be halted or forced back into oblivion again by less favourable temperatures. History's most vivid example of this is frequently pointed to to-day because of the Nazis' experiences with Soviet winter and Soviet man-power; I refer to Napoleon's attempted conquest of the vast Russian nation.

The French military leader, turning back in 1812 from his unsuccessful attempts to invade England, began mighty preparations for conquest of the one continental power still beyond his grasp. Little did he realize that the intense summer heat and benumbing winter cold of the Russian plains would offer a more effective obstacle to his ambition than any human force which had yet opposed him. Prevailing westerly winds coming in from the Atlantic Ocean provide western Europe with an equable climate—cool summers and mild winters. In Russia, on the other hand, summers are often severely hot and the winters long and cold.

The Grand Army with which Napoleon began his invasion was a motley mixture, drawn from all the countries of Europe. None too well welded together, it was by no means the compact striking force he was accustomed to using in his campaigns of conquest. Quick manœuvres and surprise blows were his chief battle assets, but this army was inclined to be cumbersome and sluggish. With it he crossed the Niemen River on June 24th (1812) to begin his most disastrous venture.

No sooner was he on Russian soil than his army became enveloped in the first severe heat wave of that fatal summer. Men died of heatstroke by the hundreds, while it is said that fully a third of his cavalry mounts were lost in the first ten days. Green forage was supposed to have produced the colic by which the horses died, but the same heat which killed the men was more likely responsible, for colic often accompanies heat prostration. Mobility for an army in those days depended upon live, healthy horses; without them the transport of equipment and supplies bogged down and the quick-striking cavalry lost its value. Not for Napoleon were the oil-burning monsters of Hitler, which provide unlimited horse-power regardless of weather—as long as the oil supply lasts.

Napoleon's first brush with the Russians disclosed the disastrous effects of the ten days of heat. Both men and horses moved sluggishly, causing failure of his battle strategy. Time after time through the summer this loss of mobility in his army permitted the Russian forces to escape the traps he set for them. The Cossack ponies, on the other hand, were inured to such weather and allowed the Russians to harass Napoleon's forces without often being pressed into pitched battle.

To-day we know that severe heat quickly devitalizes people and animals, lowering their internal combustion rate, reducing the amount of energy available for action, causing the blood pressure to fall and the individual to become in every way more like the easy-going tropical native. The heat did far more during that summer to drag down Napoleon's forces than did Russian arms. Weakened by the long summer, he finally came to actual defeat on the field of battle and began his ill-fated retreat back to the Niemen. Benumbing Russian cold then came in November to complete the destruction of his Grand Army, turning the retreat of his ragged forces into a pitiful rout from which only a handful survived. It was severe heat which began the ruin of his Russian venture and freezing cold which gave it the finishing touches.

The hand of temperature has been evident at other times through human history. People have rebelled against despotic repression during years of cold and have been more inclined to yield to the grasping power of tyrants when prolonged warmth has drained away their vitality and energy. The French Revolution itself had this temperature basis. Thermometer records at

Paris are not available for the eighteenth and first half of the nineteenth centuries, but at Zwannenberg (less than 300 miles north) monthly means are on record back to 1743. During the 34 years from 1750 to 1783 only 8 scattered years had mean annual temperatures below normal, and in each by only a fraction of a degree. In 1784, however, there began a prolonged cold period which reached an all-time low in 1789. It was in this year that the French Revolution broke out. For the 33 years beginning with 1784, only seven intermittent years had temperatures *above* the average level and then only slightly so. Thus the French Revolution and period of Napoleonic conquest took place in the only period of prolonged cold in almost a century.

In 9 of the 12 years following 1816, however, warmth again prevailed. Most of the liberties won during the revolution were lost in these years of shift back toward despotism. Severe cold and storms returned again for a brief stay over Europe in 1829 and early 1830, which was followed by an outburst of revolutionary activity over almost the whole continent. Vigorous but short-lived revolts occurred from France to Poland. Warmth quickly returned to quell their ardour, however, with only one year in the next 17 below normal. Again in 1848 a year of severe cold and storms caused smouldering discontent to flame forth into another wave of uprisings over the continent.

The history of temperature effects antedates by many centuries the invention of the thermometer and the existence of carefully kept scientific records. The high civilization of early Babylonia flourished at the head of the Persian Gulf from about 2900 to 1750 B.C.; that of Troy rose about 2500 B.C. and declined a thousand years later. The period from 2500 to 1500 B.C. coincides with one of the millenniums of cold mentioned in a preceding chapter. It was followed by prolonged warmth during which little of note was accomplished by man. About 750 B.C., however, the Assyrian Empire blossomed forth (750–612) followed by the Second Babylonian Empire of the Chaldeans (612–538 B.C.) and the Persian Empire (530–330 B.C.).

The rise of early Greece also began to gain headway about 750 B.C., with her golden age continuing to 390 B.C. Macedonia rose to the north as Greece declined, and slightly later Rome took over leadership from a still more northerly climate. There were thus two millenniums of ancient grandeur: In the first, civilization reached its highest development well south on the

Persian Gulf and in the southern Ægean Islands; in the second, high tide again returned to the people around the Persian Gulf, but important developments also took place farther to the north-west—in Greece, Macedonia, and Italy. Each of these cold periods of high tide in accomplishment were followed by centuries of stagnation and confusion during which man seemed unable to make any real headway. The last of these periods of heat and futility has aptly been called the Dark Age.

Frigid surroundings are as inimical to human accomplishment as enervating heat. With the prolonged warmth starting in the fifth century A.D., the people of central and northern Europe began a wild ferment of activity. Relieved of the benumbing cold which legend records for preceding centuries, they now multiplied rapidly and pushed southward and to the west in ever-increasing numbers. They early battered down the gates of Rome and overran the broad empire Cæsar's legions had conquered. Even the people of Scandinavia blossomed forth during the warmest centuries of this period, sending forth the Norsemen and Vikings to conquer and colonize the coast of Europe as far as Italy and westward to the New World.

Optimal temperature conditions seemed to prevail farthest north during the ninth and tenth centuries, for it was then that the people from Scandinavia colonized Greenland and Iceland and left their mark on so many points along the coast of Europe. During this period wave after wave of immigrants from northern Europe settled in the British Isles and helped give the population its present varied character. As temperatures began to recede again, in the later Dark Age centuries, the exodus from northern Europe slowed down, returning cold subdued the Vikings, and other Powers slowly emerged in middle European latitudes. Another permanent north-westward shift had taken place, however, for in the new cold epoch vigorous young nations of central and western Europe took over from decadent Mediterranean peoples the torch of civilization.

The pathway of Atlantic storms, which in early times was down the Mediteranean basin and on across Asia Minor, shifted far northward to Scandinavia in the warmth of the Viking centuries, and then settled back across the British Isles and west-central Europe for the centuries since the time of the Renaissance. Early in the sixteenth century nations under its influence began a remarkable period of exploration and conquest into all the far corners of the earth. They ruthlessly exploited any wealth found and later started colonies which grew rapidly into new centres of population. Historical developments of this last cold period have dealt predominantly with the doings of people living in the cooler half of the temperate zones.

Asiatic history, although less well studied than that of Europe, has shown similarly timed undulations. Vague records of high developments in southern China coincide in time approximately with the early civilizations at the head of the Persian Gulf, 4,000 to 5,000 years ago. Advanced civilizations existed in Siam, Indo-China, and India during the early Greek period, although their architectural remains stand to-day in an environment of people submerged in tropical lethargy. The Great Wall of China was constructed through the centuries of Roman decay in the West to hold back the increasing pressure of northern Asiatic barbarians. Shortly after the period of Viking conquests in Europe, Mongol hordes swept down over China from the north much as the barbarians of northern Europe had somewhat earlier harassed the Romans. The celebrated Ming Dynasty brought China one of her golden ages at about the same time the Renaissance and revival of learning awakened European peoples.

The sway of temperature, so evident through the intermediate and more distant past, has again come into prominence in recent years. Rising warmth over the earth is upsetting the comparative equilibrium recent generations have enjoyed. World power seems to be embarking again on its course toward more northern regions, with the two greatest of the northern giants now locked in deadly struggle for supremacy.

Personal liberty and the democratic way of life reached a high peak in early Greece; they were lost in the autocratic despotism of the Dark Ages, but achieved a slow recovery following the European Renaissance. It was perhaps at the time of Wilson's visit to Europe in 1920 that the democratic ideal of personal freedom reached its widest acceptance. Self-determination of national groups and the right to a representative type of government was insisted upon by Wilson as a basis for future world security. For a while it looked as though real altruism might be given a chance in world affairs through the acceptance of these principles and establishment of the League of Nations.

This optimistic high tide soon passed to ebb, however, as the rise of one dictator after another indicated a very evident turn back toward despotism. The turn gained initial momentum during the post-war years of European upset and economic depression, with unseasonable warmth widely prevailing. Conditions steadied down through the more prosperous and colder last half of the decade. Even more excessive warmth began in 1929, however, initiating the severe and prolonged economic depression which held the whole world in its grip for several years. With the discouragement of these hard times, people again seemed willing to listen to the glowing demagogic promises of would-be dictators.

It was during this period of severe ebb-tide in the morale of western nations that Japan thought she saw her chance for imperial expansion in the Orient. Her great dream of empire had blossomed under the stimulus of subnormal temperatures many years before. Nipponese thermometer records go back only to 1879 (at Nagasaki). Up until 1899 temperatures there were above the long-term average, but from 1899 to 1914 *every single year was colder than normal.* During this period she embarked upon her career of imperial expansion, fighting Russia for control of southern Manchuria and in 1914 grabbing all German possessions in the Far East. Some of the latter she was forced to give up in the Versailles peace settlement. Again in 1925 she demanded valuable rights and concessions in China, but was baulked by vigilant Western powers.

But two years after the economic upheaval—seeing all the Western nations preoccupied with their own domestic troubles which had ridden in with the heat beginning late in 1929—the Japanese considered the time ripe for further expansion. This time they took over the whole of Manchuria, with a watchful eye on the reaction of Europe and America. America was for prompt and positive action, but not so with France and Britain. Quick to take advantage of their uncertainty, Japan proceeded to overrun province after province in China. She met little real opposition from the Chinese until she began an invasion of the Yangtze Valley. There she encountered people much more energized by the storms sweeping down from the highlands of Tibet. By hard fighting she finally conquered the lower and middle Yangtze Valley, but beyond that she was been unable to go.

By driving the Chinese westward up into the highlands of the interior, Japan has probably performed a great service for her enemy. The Chinese army and tens of millions of the most progressive inhabitants of the coastal cities have thus been pushed back into a much more invigorating climate. The Chinese are a tenacious, ingenious people and, under the stimulus of Chungking's climate, are rapidly developing the resources of that upland region. Much of the country's underground wealth lies there still untouched. Perhaps China will become awakened for another golden age by this forced migration of her most intelligent and capable people into the more energizing interior.

Here the hand of temperature is affecting the course of history still in the making. Instead of ruining China by overrunning her rich coastal provinces, Japan may instead have provided just the stimulus needed for the Chinese to lift themselves out of their long period of apathy. Perhaps it would be wise for the Chinese to keep Chungking as their permanent capital and continue with the development of that rich, more stimulating upland region.

This factor may play an important role in the future, for the stronger China becomes the stronger will be the general position of all the other United Nations. Meanwhile, Japan is still riding the wave of her 1899-1914 period of energizing lower-than-normal temperatures. Her rapid progress from Thailand through Malaya, her conquest of Singapore, her successful invasion of the Dutch East Indies, and her drive through Burma toward India have all been examples of an impelling energy which was at least initiated by great changes in the surroundings of the Oriental island. That brief period of subnormal temperatures also had an indirect effect all over the world, for Japan's seizure of Manchuria, without effective challenge from the West, convinced her that the time was ripe for a New Order in Asia; it also demonstrated to the Western dictator nations that they could go ahead with their own empire-building plans.

Not long afterward Mussolini began trying to mould the destinies of Italy by adding Ethiopia to his African empire. Forces even greater than Il Duce had been taking a hand in moulding Italy's destiny for many years; for her long fight for freedom from the Austrian yoke took place during the period from 1845 to 1861, when temperatures at Rome were above average for not a single one of the seventeen years. The situation has been quite different in more recent times, however, for uninterrupted warmth since 1921 has kept the Italian people pliant under the hand of their dictator. Mussolini's dream of a great Mediterranean and African empire has been quickly shattered by the blows of armies from more invigorating climates. He lost not only Ethiopia but Eritrea, Italian Somaliland, and parts of Libya as well, and only the intervention of Nazi divisions under General Rommel prevented a total rout in the latter country. Never in modern times have the people of tropical or subtropical climates been able successfully to oppose the might of more favoured nations.

Soon after Japan had revealed the weakness of the West by her successful conquest of Manchuria, the Nazis began arming for conquest. As the world warmth abated somewhat in 1936 and 1937, the Germans became more aggressive in their expansion and soon began their forcible absorption of the smaller surrounding states. The Saar Basin, Austria, and Czechoslovakia were taken over with only verbal protests from the more democratic Powers. With the seizure of Danzig and the invasion of Poland, however, France and England finally came to a reluctant decision and declared war. The rigours of actual fighting now found the Germans well prepared and with vigorous striking power; France and Italy lay more or less supine, the British on the defensive. Little obstruction was offered to the Nazi conquest of the Continent until they turned to eliminate the Russian forces. Now those two mammoths of the north are locked in the bloodiest and most destructive war of all time.

Subjugation of the German war machine, with its complete dominance of the resources of Europe, will be a difficult task for the United Nations unless Nazi strength can be sufficiently drained in the Russian conflict. In any event, it will take a powerful coalition to crush Germany and prevent her from attaining that dominant position in world affairs which may be due—climatically speaking—as earth temperatures proceed with their long upthrust and the time approaches for another northward shift in European power.

The Germans came very close to winning their place in the sun during the first World War, for then as now they possessed a most vigorous fighting prowess. It may have been temperature which foiled that first bid for world power, for unseasonable warmth prevailed throughout Central Europe from June of 1917 to July of 1918. Temperatures in France and England remained close to normal levels for the period, while that winter in America was the coldest on record for a half-century. The American forces surviving influenza and pneumonia in our training camps during that winter reached the European fighting front the following spring and summer with an exuberance of energy which quickly smashed through the tired battle lines to victory. It can never be known just how much the year of unseasonable warmth had to do with the crumbling morale of the Central Powers in the late summer of 1918, or the Western cold with the final victorious push of the Allied armies. Too many other factors were at work to make an essay of this one temperature element anything more than a guess.

Truly democratic government has lost much of its representative nature through the recent period of rise in autocratic dictatorships. Only in the Anglo-Saxon and Scandinavian countries has the parliamentary form continued to function; and in most of these there has been a strong shift toward group rule, with Labour climbing into the seat of power. The regimentation needed in the long fight ahead against Nazi Germany will lead us still further along the road to autocracy. Wealth accumulated through past centuries of expansion is now being rapidly dissipated on the fields of battle, so the present destructive struggle may greatly accelerate any downhill trend which lies ahead.

CHAPTER 20

CLIMATE AND WORLD WAR

FORCES BEYOND HUMAN CONTROL continue their irresistible course to-day just as they did through past centuries of racial history. In the mighty upheaval now going on, any country which expects to come out on top must give careful consideration to the effects these outside influences have on the health and fighting vigour of its men. War must now be waged under unique and often dangerous environmental conditions. New disease problems are raised, especially in the tropics where the warmth so enervating to human beings is favourable to the growth of germs and parasites.

Recognition is being given to these disease problems by the present active search for new anti-malarial drugs to replace the quinine formerly obtained from the East Indies and Malaya. The most recent annual report of the Rockefeller Foundation tells of the production in its laboratories of 4,000,000 doses of yellow-fever vaccine for use by United Nations armies engaged in tropical warfare. Added to the threats from the swarming disease germs in tropical heat is the discovery—mentioned in Chapter 2—that the bacteria-fighting white cells in the blood become sluggish and ineffective in hot surroundings. There is need for intensive and co-ordinated study of what tropical heat means to man, as well as for further studies into better methods of handling the infectious agents themselves.

A strong connection exists between vitamins and susceptibility to disease, for people deprived of their normal requirements are likely to contract maladies they would never have had otherwise. There has been much discussion in scientific circles about the enforced vitamin starvation of entire populations in the occupied countries of Europe. Well aware of the vital significance of an adequate vitamin intake, the Germans have been very careful to keep their armed forces and home workers as well fed as possible. Their first act in a newly occupied country is to strip it of vitamin-rich foodstuffs, particularly the cereal grains and animal products which carry most of the B vitamin supply. The result has been a severe and almost universal underfeeding of home populations in the occupied lands. More devastating than the simple food scarcity, however, has been the vitamin starvation resulting from this German policy. Many scientists have professed to see in this an intentional effort by the Germans to weaken the morale, as well as the physical condition, of the subjugated people and thus to lessen the likelihood of vigorous revolt against the German rule.

Any such vitamin starvation policy is a two-edged sword, however, for it will mean a marked lowering in disease resistance. Tuberculosis, typhus, and a host of other deadly infections will spring up over the Continent if any such policy is long continued. Certainly no wise nation would wish this type of disease wall around its borders or among the people with whom it must come into intimate contact during future decades. The present epidemic of typhus raging in parts of Europe may be one of the first fruits of this German policy. It is hitting most severely in occupied Poland where the people have been forced into crowded ghettos in semi-starving condition. Mere concrete walls thrown around these pest areas failed to keep the disease within bounds, for now it is spreading rapidly throughout that section of the continent. Years of similar semi-starvation in Spain gave rise during the past winter to an epidemic severe enough to prevent the German forces from using this pathway to African battlefields. Disease is a severe and ruthless tyrant, and any people who knowingly allow it to gain such mastery should prepare to pay a terrible price for the devastation it will bring.

It is well known that even under normal conditions people need higher-calorie foods during extremely cold weather, when the body has natural difficulties maintaining internal temperatures at the optimum level. American troops in Newfoundland, Iceland, and increasingly important Alaskan bases require up to 10,000 calories a day, as contrasted to the average sedentary worker's standard of 2,500 calories. Men in these important and frigid outposts receive one-third more bacon and other fatty meats, as well as 20 per cent. more vegetables. Some nutritionists doubt whether it is physically possible for men to eat more than 5,000 calories a day for any continued period. Some years ago, however, six young American physicians consumed 6,000 calories daily for 3 months without trouble or difficulty—and they were leading a relatively inactive and sheltered hospital existence at the time. I recall one obese patient whose gluttonous appetite was causing him to ingest 6,500 calories a day, even though he was engaged in almost no physical activity.

Supplying food to tropical armies presents other peculiar problems of immediate importance to the welfare of the men. Although soldiers eat less in the heat, they need food much richer in the B vitamins to meet their higher requirement. Meats usually supply the larger part of the needed B vitamins, but tropical meats are deficient in them, so commissary departments must see that vitamin-rich meats are shipped from temperate climates.

Fighting men everywhere, but especially in the tropics, need all the energy they can get from the food they eat. Plenty of exercise helps to keep vitality high if the diet is adequate. It is probably safer to give the men in tropical service supplementary supplies of the B vitamins, however, even though most of their animal products be shipped from good growing lands. A crude liver extract or brewer's yeast is probably the most practical and concentrated source for daily use. In them, both known and unknown B fractions are present in fairly well-balanced proportions. Tablets of the purified or synthetic vitamins sometimes lack sufficient quantities of the unknown fractions which now seem even more essential than thiamin for hot-weather existence.

There have been definite suggestions that over-dosage with the purified vitamins can produce toxicity more readily in tropical heat, even though the requirement is higher than in cool climates. This is also true of some of the body hormones (internal secretions). Tropical residents tolerate thyroid extract and insulin poorly, for very small doses of these two products have been known to kill tropical patients. Some years ago I reported the tendency of patients in the severe summer heat of Peking to go into fatal insulin shock from doses considered insignificantly small in the northern United States. It is safer, therefore, to provide the vitamins in some crude natural form rather than in synthetic tablets when giving them routinely to people without careful watch of each individual. A person is quite unlikely to take too much yeast or liver extract.

I suppose this talk regarding the value of brewer's yeast will lead someone to suggest the advisability of beer-drinking. Since the yeast grew in beer, why should't it too be rich in the vitamins? Perhaps it should be, but it isn't. Beers and wines contain practically no vitamins. It is only when the yeast cells have been digested or broken down that they liberate their stores of these materials. On that account it would probably be best to admininster yeast in a slightly cooked form rather than to give it raw. Boiled for just a few minutes with a quick-thickening breakfast cereal, it provides a dish which might serve a very useful purpose in either tropical heat or temperate coolness. Two of the best cereals for this purpose are oatmeal and wheat hearts. Both are already rich in the B vitamins as well as in actual food value. Wheat hearts usually sell as stock food at a small fraction of the price people pay for less valuable packaged breakfast foods.

The suggestion of mixing dried yeast with peanut butter and regular butter as a table spread would also be readily applicable for use with armed forces in tropical countries. The yeast taste is thus largely masked by the peanut butter, which is itself also rich in the B vitamins. Two ounces a day of such a mixture would cover the extra B requirement in any climate. So also would a tablespoonful of concentrated liver extract taken twice a day.

Vitamin requirements are indirectly affected by climate, but the atmospheric surroundings exert another important, less publicized, and more direct effect on human beings. Never before in all history have large masses of men been shifted so abruptly and in such numbers from one climatic extreme to another as to-day. Japanese troops have fought from the severe cold of northern Manchuria to the steaming jungles of Malaya and the East Indies. Germans have engaged in disastrous efforts on the frigid plains of Russia as well as on the Sahara sands of Africa. Our own American troops have been scattered from the polar cold of Iceland to Philippine heat. Fighting forces of the British Empire are facing almost every conceivable climatic condition. Quite aside from germ threats, there must also be faced the marked disturbances in body physiology described in these pages, as men shift suddenly from heat to cold or vice versa.

Fortunately, most of the troops going by ocean convoy to tropical stations in the Far Eastern fields are subjected to several weeks of mild tropical warmth on shipboard. They are thus partially acclimated before they land in the severe lowland heat of those regions. They should be given regular and vigorous exercise during the warm ocean voyage to prepare them for the greater difficulties in heat loss they will face on landing. German troops destined for African service were said to have been given daily exercise in heated rooms for weeks or months before leaving for the front. Long preparation would not be so beneficial, however, as more intensive training for the two-to-four weeks immediately preceding landing in tropical heat.

Real difficulties are faced by men from stimulating climates who land in such lowland heat without the benefit of previous adaptation. These difficulties are greatest for those arriving by air, for their descent into the surface heat is most abrupt. Frequent change from severe surface heat to the cold of upper air puts great stress upon flying personnel engaged in tropical service. Wherever possible, they should be provided with cooled ground quarters. They need the active, vigorous metabolism most readily maintained in cool surroundings.

Just before the outbreak of war with Japan a high-ranking naval officer, invalided home from Manila, came to me with a very typical story of troubles arising from too sudden entrance into tropical heat. He had been on a tour of duty at ports in the northern United States when he was suddenly called for a Manila assignment of great responsibility. Leaving his post in Oregon, he went directly to Manila by clipper plane. He had previously had many years of tropical service, but most of this time had been spent at sea where the heat is less severe. This time he landed directly in the Manila heat and stayed on land for administrative duties. In rather short order he was suffering the digestive disturbances and fall in blood pressure common to heat exhaustion. He tried using cooled office quarters, but the abrupt contrasts of entering and leaving from outdoor heat only made his condition worse.

Finally invalided home, he was greatly chagrined to be still on sick leave when war broke out. He is now rather rapidly recovering and, with knowledge of the proper hygiene of living in tropical heat, should soon be ready for active service again.

There will be many similar cases of heat effects among the thousands going directly into tropical heat from the winter climate of the northern United States. Expert as are the Army and Navy medical men in handling the tropical disease problems of bacterial and parasitic origin, few of them have given much thought to these disabling disturbances in body physiology which arise from the direct effects of the heat itself.

Tropical fevers and infections of various kinds have taken a considerable toll among the forces fighting in the lowlands of the East Indies, Malaya, and southern China. One of the most important reasons for Bataan's fall was the presence of malaria and other ailments among the courageous American defenders. So long as drug supplies hold out, however, this toll is now insignificant compared to what it was a half-century ago, before modern medical methods of prevention and treatment came into force. Perhaps proper measures to maintain the highest possible vitality will still further reduce the ravages brought by these hosts of minute tropical enemies. They are always to be feared more than those in human form. Japanese conquest of the East Indian sources for the world's quinine supply may prove to be one of her major victories over the United Nations unless other effective anti-malarial drugs can be discovered and produced quickly.

The British had always considered Singapore safe from land attack because of the fever-ridden Malayan jungles; but the Japanese attention to minute detail seems to have provided effective protection for their men. Without adequate supplies of quinine or other good anti-malarial drugs, such jungle campaigns would indeed have been impossible.

Still more dangerous than sudden transfer of troops from temperate coolness into tropical heat is a sudden shift in the reverse direction. Pneumonia, tuberculosis, and a host of other respiratory infections take a tremendous toll among troops shifted from tropical homelands into winter fighting on northern fronts. As we have already noted, in the First World War tuberculosis among the African troops fighting in northern France became almost as acute as pneumonia, running a very rapid and often fatal course.

It would be disastrous for Italian soldiers to attempt winter fighting in the polar cold of the northern Russian front. Even in the much milder weather of the Crimea they are no match for the more energetic Russians. Germans from the more stimulating climate of north-central Europe are encountering considerable difficulties in the severe Russian cold. Their difficulties, however, arise largely from lack of proper dress for polar temperatures. Garments made of animal skins or furs are the only ones capable of protecting against those wintry blasts; only thus can the internal body heat be preserved against too rapid loss. The Russians have always relied on heavy furs for winter use and hence have kept themselves well supplied; but the men of Axis countries have never needed or used much of this type of winter clothing. The Eskimo, in his suit and hood of skins, is almost immune to outside Arctic cold.

Thus we have at least a part explanation of the vigorous Russian offensive against the Germans, who froze arms and feet by the thousands in the enforced winter fighting. The German General Staff foresaw this danger and urged the formation early in November of a winter defence line with heated living quarters. Hitler gambled on paralysing the Russian forces by a knockout blow before winter closed in. His gamble backfired and his unprotected troops paid a terrific price in their enforced activity at sub-zero temperatures. It was this same catastrophe which overtook Napoleon, after he had dallied too long on the Russian plains, with his troops inadequately clad for the cold of a Russian winter. Present-day tanks and aeroplanes may be immobilized as the bitter cold freezes their lubricating oils, but the shaggy-haired Russian cavalry pony is then in his element.

In a country like ours, with marked climatic differences between northern and southern sections, it would seem wise to use northern troop units for garrisoning Newfoundland, Greenland, and Iceland, or for active fighting in northern Europe or Asia. Troops of southern origin, on the other hand, would be better adapted for service in tropical heat. Training of the present army has been conducted largely in camps located in the south or along the Pacific coast. This undoubtedly has lessened the respiratory disease hazard, and the southern summer warmth has partially prepared the boys for facing real tropical heat; it does not, however, fit them so well for transportation to cold fighting fronts.

In returning the sick and wounded home from tropical fighting fronts, careful consideration must again be given to climatic and weather effects. They face severe respiratory disease hazards if brought directly into the cold and storms of a northern winter. The non-stormy South-west offers the ideal climate for their recuperation; several base hospitals and large convalescent units should be established there. Men from colder regions of warfare can safely be sent to treatment centres in other parts of the country.

At the close of the war, men who will have spent many months fighting in tropical heat should be demobilized with care. Great distress and a widespread epidemic of respiratory disease might result if they were returned *en masse* to their northern homes during the colder seasons of the year. It has been suggested that the ravages of the terrible influenza and pneumonia epidemic of the 1917–1918 winter were perhaps made much worse by the thoughtless transportation of tens of thousands of southern draftees to northern cantonments.

Whatever places become future battlegrounds—whether it be Ceylon, Madagascar, Dakar, Alaska, or Arctic regions near the northern supply route to Russia—it is apparent that special provision must be made for troops who are shifted from temperate zone climates to far different surroundings. This, to be sure, is only one of many problems facing the world's military leaders. But it is an especially important problem, for it involves the efficiency and morale of the fighting forces—and the war will be won by soldiers who are as efficient and as high in morale as possible.

Recently there occurred one of the most impressive demonstrations of the part climate is playing in the fighting melee of to-day. The eastward onrush of Rommel's armoured force across northern Libya and Egypt—coming at a time of year when it was maintained that severe desert heat would render tank warfare impossible—is now rumoured to have been made possible by the use of air-cooled tanks. The Allies had considered such air-conditioning, but had discarded it as not feasible because of the tremendous weight of the cooling equipment involved. Some time ago I suggested the use of the radiational cooling scheme described in Chapter 15, since it would provide insulation against outside heat as well as cooling of the tank occupants with a minimal mechanical load. Military authorities are considering the matter, but it now seems certain that American science will have to join more closely with industry and take a direct part in the carrying out of the war effort of the United Nations.

CHAPTER 21

MIGRATION FOR HEALTH

THE CASE OF MR. X IN CHAPTER 8 was one example of the advice which may be given in answer to the query, "Where is the best place for me to live?" This question has been put to me time and again by persons learning for the first time of the climatic and weather dominance over their lives. For the chronic sinus trouble of Mr. X I advised permanent migration to the South-west, but other climatic regions also have their good points. Obviously there can be no single answer, for much depends upon the person's physical condition and what he wishes in life. If he seeks healthful contentment and real pleasure in living, then the ideal climate will be such as the American South-west offers at 4,000–5,000 feet elevation, or at still higher levels farther south in Mexico or the Andean highlands. There moderate stimulation keeps alive one's interest in life, without the impatience and boundless enthusiasm which make existence in colder, more stormy regions so irritating and unsatisfying.

If it is a life of indolent, effortless ease he desires, he should head for tropical heat where that kind of existence prevails naturally. But for a life of accomplishment and activity, of keen competition and initiative, of restless energy in both brain and body, let him choose the stormy climates of middle temperate lattitudes. If such be his choice, however, he should be prepared for a life of strife at every turn—strife in home relations and discipline, strife in business, strife in public and international affairs, strife in old age, and strife even in trying to hold death at bay.

The stresses of northern life, however, give evidence of being serious health factors, particularly for people who have passed middle age and lost the resiliency of youth. Cold weather bothered them little through their younger years, but with advancing age they chill more easily and meet sudden temperature changes less well. The slower, easy life of warmer climates exercises more and more of an appeal to these people with each passing year, and midwinter sees those who are able heading southward. The automobile trailer was originally developed to meet the needs and desires of these winter migrants to the sunny Southland. Its success with them soon led to its widespread use for family travel of all kinds, but it still remains predominantly a means of north-south seasonal migration.

Like the sap in a mighty oak, automobile trailers begin to leave their northern outposts with the first autumn frost. Trickling along the roads at first singly, then in increasing numbers, by Thanksgiving time they flood the main highways to the South. They line up by the thousands in Florida's regimented trailer parks through the winter months, their carefree occupants basking in that delightful winter atmosphere. Early March finds them moving back northward with the robins, fanning out in all directions to reach their New York, Michigan, or Minnesota homes for the opening of spring. There they stay from the time the leaves open until they change colour and flutter to the ground in autumn.

Development of the trailer seemed for a while to offer Americans as nomadic a life as they might wish. People in their fifties and sixties quit struggling against the rigours of northern winter life, rented or sold their houses, and took to a trailer existence. South in winter, north in summer—they were then as free as the birds to choose the temperature of their environment.

Younger couples by other hundreds of thousands were forced from their homes during the long period of economic depression and by widespread droughts in the plains states. These hordes headed westward, as have nearly all migratory masses since the beginnings of the race in Central Asia. Constant streams of them poured into California and the Pacific North-west, with the whole family and a few household belongings piled into the most ramshackle conveyances imaginable. Without funds or chance to work, these wanderers soon swamped all relief facilities in the coastal states. Camping in any available spot, but especially along the mountain streams, by their unsanitary life they raised real disease hazards for the surrounding communities and forced Governmental attention to focus on their problems.

For several years West Coast authorities struggled with the handling of this nomad population without much success. Booming war industries have now provided temporary employment and means of support for many of them, but their basic peacetime problems still remain. Similar medical problems arise from the thousands of migratory labourers who follow seasonal employment northward from early spring to late autumn, with no home except the tents or trailers they and their families occupy. From strawberry-picking in February, they move northward by easy stages with the ripening of the crops, both in the East and in the Far West.

States and smaller settled communities have found it necessary to put the same restrictions and obligations upon these homeless migrants as they do upon their own permanent inhabitants. In a sparsely settled country few hygienic restrictions are needed, but when many millions of people are concerned, careful watch must be kept of the factors which promote the spread of disease. The trailer and free movement of families from place to place threatened to become such a menace, in addition to creating difficult school and public service problems; hence rules and regulations are gradually being worked out, again placing on these people their proper responsibilities as members of a civilized society. The complete freedom thus seemingly offered by the trailer in its early years is gradually being replaced by the cares of a settled life, as indeed it must in any densely populated land.

In spite of these problems, however, America is on the move again. Perhaps because of our driving climate, we have never been a people to strike deep roots into the soil of a given locality like the more fixed populations of the Old World. Few of our homesteads are handed down for generations within the same family. Being thus somewhat nomadic by disposition, we should be well able to avoid any climatic or weather situation not to our liking. We have at hand the means and the disposition: it only remains for us to acquire the knowledge as to when and where we should move.

There are several large classes of northerners who would benefit from seasonal or permanent southward migration. The largest of these includes the millions of elderly people whose tissue fires have pretty well burned out or become choked with the clinkers of degenerative disease. With their arteriosclerosis, diabetes, chronic nephritis, heart troubles, and a host of other chronic ailments, they are no longer fit for the physical struggle it takes to survive the stormy cold of northern winters. Younger and more resilient individuals match the rigours of winter with a heightening of their own vitality and bodily vigour, but the winter battle is too strenuous for the brittle oldster. With his lowered rate of internal heat production, he chills easily; and with each chilling his already sluggish white blood cells become still more inactive, leaving him especially susceptible to pneumonia, bronchitis, and other respiratory infections.

Untold numbers of elderly northerners have found benefit from wintering in the South or from moving there for permanent residence. Many others should realize the value of such a move in giving them a more prolonged and healthful existence for their declining years. Day-by-day activities in southern warmth follow a less energetic pattern and fit better the slower combustion rate of body tissues in the later decades of life. The energetic northerner finds it difficult to keep up his working enthusiasm after a few months in tropical warmth. Money-making schemes seem less enticing when the body heat generated in their planning and execution is difficult to dispose of. So the retired northerner who finds idle life such a bore should go south and let the warmth fit him to a slower tempo of affairs.

Such advice is particularly appropriate for any person whose arteries have hardened under the stress of northern life and whose heart has narrow limits to the work it can perform. Such people, and their diabetic brethren, would add years and increased comfort to their lives by getting away from the invigoration of cool climates. The farther they move into tropical heat the better it will be for them. Southern Florida, the Brownsville district of Texas, or Southern California—these should be their havens of refuge within the borders of the United States. Northern Florida and the northern Gulf coast offer a delightful climate for winter vacationing, but only during the summer months is their warmth sufficient to subdue an active body metabolism.

Migration to Cuba, Puerto Rico, or Panama would be still more effective, but few Americans care to go beyond the borders of their homeland for permanent residence. Wintering in some tropical country would be helpful, but the return to northern homes could not safely be made before April or May, when all danger of cold weather has passed. Several weeks or months of tropical warmth would bring a sharp lowering of the body's resistance to respiratory infections, leaving the returning individual overly susceptible to colds, bronchitis, sinusitis, and pneumonia.

The millions of people afflicted with repeated respiratory troubles each winter form another large group who would benefit greatly from permanent or seasonal change of climate. They should not seek tropical warmth, however, but rather a non-stormy region with moderately invigorating climate. Within the United States such climatic conditions exist only in the South-west, within about 200 miles of the Mexican border from El Paso to the Pacific coast. Cyclonic weather disturbances practically never bring their sudden changes in temperature and barometric pressure to that region. People living there are in the main remarkably free from the respiratory and rheumatic troubles storm changes bring elsewhere.

Tucson, Phœnix, Albuquerque, or other valley cities of that region offer delightful wintering spots for respiratory disease sufferers, but for year-round residence a more elevated or slightly more northern location should be chosen so as to avoid the severe daytime heat of the summer months. The southern California climate is also good, except along the immediate coastal fringe where the constant inshore winds laden with ocean moisture exercise a bad influence. This ocean moisture is especially bad during the midwinter months, when thick fogs often prevail. A permanent residence for sufferers from respiratory disease should thus be located well back from the coast (30 miles or so), and preferably 2,000–3,000 feet above sea-level. The South-western climate is the best America has to offer people whose lives are made miserable by one respiratory infection after another through the stormy winter months. Similar benefits are offered European sufferers by the mild climate of the Mediterranean Basin and northern Africa.

Many persons have found their sinusitis or chronic bronchitis made worse instead of better by a midwinter sojourn in the Caribbean or Gulf coast regions. This happens for two reasons. First, the warmth lowers their tissue vitality and allows the infections they carry in chronic form to become more active or acute; second, hurricane-type storms sweep westward across the West Indies through the autumn and early winter, bringing somewhat the same influences on man as do the cyclonic storms of northern winters.

Removal to the South-west is most imperative for people attacked by acute rheumatic infections of the joints or heart valves. Unfortunately, these attacks are most frequent among poor people who are bound to their place of abode by the iron chains of poverty. Real tragedy often faces a child in whom rheumatic infection begins, with one attack after another bringing increasing damage to the heart and finally ending in complete invalidism or death. Transfer to the non-stormy South-west usually prevents new attacks and allows gradual repair of the heart damage.

Economic handicaps unfortunately prevent most people from availing themselves of the benefits such changes of location offer. Here would seem to be a logical avenue for federal action in the interests of the public health. Establishment of convalescent colonies or health farms in irrigated valleys of the South-west might allow many people now incapacitated by respiratory or rheumatic infections to regain their health and again become self-supporting. The home communities of many such patients would find it less expensive to finance migration than to pay for the repeated hospitalizations required if the victims live on where their disease progresses from bad to worse.

A more enlightened public-health attitude would also aid thousands of elderly people to move from the north to less energizing southern regions where they could lead a more comfortable existence and at the same time be fed and cared for more cheaply. America is only just beginning to consider the problems of its ageing population. As their numbers become still more numerous in the decades ahead, and the public conscience becomes more aware of their handicaps, perhaps steps will be taken to aid them in finding southern homes for their declining years. Many will not care to leave family and friends for such a move, but the possibility of doing so should not be limited to the well-to-do as it now is. A man who has spent his life labouring with his hands in the nation's workshops has earned the right to a comfortable old age just as much as has the well-paid executive who directed his labours. Some travellers have reported Russia as being far ahead of us in such matters, with numerous health resorts and convalescent colonies for working people dotting the Black Sea shores.

Hay-fever sufferers who fail to obtain relief from desensitizing injections often find removal to another locality a great help. After discovering the particular pollen to which they are sensitive, they should seek a region where that plant does not grow and stay there during its blossoming season. Owing to the desert conditions generally prevailing in the South-west, the air there is usually free of pollen, and that region is a favourite resort for hay-fever victims. Injection treatment at home is less expensive than yearly migration, but it usually must be repeated just before each hay-fever season. Many such sufferers choose to take their annual vacation at their season of trouble and go away to an atmosphere free of the particles which bother them.

Still another class to whom the non-stormy South-west should appeal is the type so very sensitive to change in barometric pressure. For many people the days of sharply falling pressure mean real misery—headaches, migraine attacks, melancholic moods, restlessness, and hyper-irritability. Often it is the lining mucosa of the nose and sinuses which is sensitive to weather change, puffing up with the approach of stormy weather to clog the sinus openings and bring acute discomfort. Many so-called sinus headaches arise on this basis. For such weather-sensitive people the South-west offers great benefits. Some of them are so extremely susceptible that they are affected even by the minute pressure changes occurring at Los Angeles, but for most that climate affords almost complete relief.

What about migration for the southerner? His greatest benefits come from avoidance of the depressive summer heat. Nearby mountain or seaside resorts serve him best. To escape the heat by going northward up the central trough of the continent he would need to travel almost to the Canadian border, else he might encounter summer heat even more severe than at his Gulf coast home. Southerners or tropical residents suffering from low vitality and heat debility—children especially—often obtain marked benefit from a few weeks in northern coolness. They should take care, however, to leave the North before the winter storms begin, else they will encounter severe respiratory disease risks. Among the thousands of labourers and draftees who came up from the southern states during the First World War, winter cold and storms exacted a truly terrible pneumonia toll.

The only change of climate possible for most people must be squeezed into their year's brief vacation period. When should this vacation be taken, and where should they go? The answer will depend upon the type of person concerned. For the energetic, dynamic type of northerner, a January or February vacation in southern warmth is best, since it gives a restful break in the long period of winter stress. Such people should stay on the job during summer warmth so that the heat can slow them down somewhat. That is their yearly chance at the biologic rest they stand in great need of, for their greatest health dangers arise from the breakdown and exhaustive diseases such as heart failure or diabetes. With their high metabolic rate, they usually dislike summer heat, although they need its calming effect.

Many less dynamic northerners find themselves slumping into tropical lethargy in summer heat, or perhaps they develop symptoms of mild heat exhaustion—low blood pressure, weakness, loss of appetite, lassitude, etc. For such people vacations had best be taken in a cooler locality through the worst of the summer warmth.

Finally, there are those who do poorly in both winter cold and summer heat, those exhausted neurasthenics or people with a constitutionally subnormal physique who need to migrate with the birds—north in summer and south in winter. Such people are fortunate indeed if they possess the means to finance travel; otherwise they make themselves and everyone around them miserable by wanting high indoor temperatures in winter and by constantly reminding everyone of how hot it is in summer. Their distress is unquestionably real and is often best relieved by intensive B vitamin therapy to reinforce their tissue combustion processes.

The day may not be far distant when our knowledge of nutrition will enable us to maintain a high energy level in tropical heat. Proper use of the B vitamins—the combustion catalysts—may make this possible, liberating tropical residents from the lethargy which has smothered all initiative up to now. The boon to mankind would be great indeed if the material wealth and productive capacity of tropical lands could be matched with a more effective energy level in the native inhabitants or in people migrating there from cooler lands.

One very minor type of migration for health is needed in the industrial cities of the earth. People should abandon—for residence purpose—those districts where atmospheric pollution raises severe respiratory disease hazards. Movement to homes out in cleaner suburban air will pay high dividends in health. In such change of location study should be made of local topography and prevailing wind direction so as to avoid the stream of smoke-laden air. This outward shifting of city populations has long been in progress, and has been responsible for destructive shrinkage in downtown real-estate values. Smoke and industrial dirt thus cast their pall over economic values, as well as over the people's health. Some day an aroused public will demand that proper steps be taken to relieve this wasteful and unsightly situation.

It is true that the great majority of people are not sufficiently bothered by climatic and weather handicaps to justify the breaking of long-established business and social relationships for removal to a different climate; but if all climatic or weather victims in the North were to re-locate in the South or South-west, those regions would become densely populated. Florida could handle millions of oldsters on small plots of land, but much more irrigated acreage would be needed in the South-west to support the army of weather refugees who would head in that direction.

While we as a nation were young and lusty, we gave little attention to these matters; now that the proportion of elderly people in the population is rapidly increasing, more thought is being given to environmental handicaps and the advantages different regions have to offer. Elderly people started the winter movement to the South, and they will probably be the pioneers also to other regions. With their waning vitality they feel the handicaps most keenly and are often best situated economically to make the needed change of location. People retired from their life-time occupation, pensioned war veterans, widows left with enough insurance money or other accumulated wealth for their support, young people out of college looking for a place to begin the real business of life, invalids, and many others are the ones who should give thought to the climatic factor in life and what it might mean for their health and welfare.

CHAPTER 22

FROM FLOOD TIDE TO BEGINNING EBB

OVER 2,000 YEARS AGO the people of early Greece reached levels of development fully as high as those of to-day along social, economic, and philosophical lines, but they lacked the mechanical ingenuity which has brought to us the Golden Age of the Machine. To-day the machine has so woven itself into our lives that it completely dominates every phase of existence. Look around wherever you are—at the clothing you wear, the books or papers you read, the furniture you use, the building sheltering you, your means of transportation and communication, the food you eat, even the conditioned air you breathe—all show the work of complicated machinery. Man's activities have expanded at an ever-increasing rate through recent centuries, with the application of an inventive and scientific genius such as had never before been seen.

During the rapid advance through this astonishing mechanical age, man expanded also in other ways. His numbers over the earth more than doubled in the nineteenth century alone. He increased also in his individual stature and came to maturity at progressively earlier ages. Fathers regularly saw their sons grow up to tower over them, mothers found themselves looking upward into the faces of their tall daughters. Not very favourable to parental discipline, this having children in their teens look down upon their parents!

Stature improvement since Revolutionary days has indeed been remarkable. The soldier of to-day is four inches taller than the private of a hundred and fifty years ago and has more weight for each inch of height. College student records in some American schools go back almost a half-century, and even in that short period the freshman boys have shown a two-inch gain in average height. Junoesque figures for the girls may mean good health, but they occasion much social embarrassment, since few boys like partners taller than themselves. The social problems of the tall girl are real and in some places are being met by the formation of clubs for tall people of both sexes, where everyone is up on the same level.

The rapid gain in stature of recent times has brought other amusing and troublesome problems. Mr. Pullman built his first sleeping car in 1859 with a berth length of 71 inches from the centre of one partition to the next, patterning his berths after those in use on passenger ships of that day. In his next model brought out 6 years later he increased this berth length to 72 inches. Continued complaints from travellers caused a further increase to 75 inches, and finally to the present 77½-inch mattress length in use on the sleeping cars recently put into service. Cabin berths on ships caused their occupants similar cramped inconvenience until the passenger liners changed over to full-length regular beds. Plenty of ships still in service use the old-style berths—far too narrow and short for the well-built man of to-day. Seating space in theatres and other gathering places also provides entirely too little knee and elbow room. Building specifications simply have not kept pace with the changing stature of the occupants.

Many of the really old beds now in existence are much too short for their present owners. One of my friends, a well-built man, bought a pair of beautiful antique beds for his seaside cottage, but found that a 6-inch elongation of the side pieces was necessary before they fitted his size. King George of England, in his pre-war visit to Paris, was given Napoleon's bedchamber and Napoleon's own specially made bed for his use. Press reports of the visit failed to mention just how he spent the night, but Napoleon was 5 feet 2 inches in height and King George is about 6 feet! Even the longest diagonal of the bed must still have lacked several inches of providing sufficient room for him to stretch out in tired relaxation.

The wife of a colleague on the university faculty loaned me an old Crew List she had inherited from her New England ancestors. In it were listed the heights and ages of men signing on for a schooner voyage from Marblehead to Leghorn in August of 1801. Most of the men were in their middle twenties and their average height was 66 inches. New England young men of to-day are about 4 inches taller than this. One member of the crew was a 13-year-old cabin boy with a height of 56 inches, whereas both of my sons at 13 have been 66 inches! It is no wonder old-time sleeping berths were so short—they were ample for the men using them in those days.

The average man is now about 70 inches tall in various regions over the earth where recent human progress has been most marked. Anthropologists say that this is about the height attained by various other human groups back through the centuries as they reached the pinnacle of their development. The ancient Egyptians and Greeks, the Romans, the early Indians of the American South-west, all achieved this stature at the height of their glory and then declined in size as well as in culture.

With the one long decline of historical times—the European Dark Ages—man receded far from his former peak in both culture and body size. The knights and nobles wearing the suits of armour in those dark centuries would be mere pygmies compared to the picked soldiers of to-day. Even a well-developed American boy of 14 would have great difficulty getting into most of the suits of armour now on exhibit in the world's museums. If the picked fighters of those days were small, fine-boned men, the common people must have been puny indeed. And the damsels, who so often seemed in need of rescue by the knights, were really females in miniature who came to sexual maturity about 3 years later than do our self-sufficient girls of to-day. Back in ancient Greece, on the other hand, the women were well developed and began their sexual cycles at the same early age prevailing among the most advanced of present-day girls.

European people of the Dark Ages seemed to be of low vitality in every way. Small in body and late in developing, they were also subject to pestilences which repeatedly lessened their numbers. Poor transportation and economic chaos greatly increased their difficulties in securing proper food, leaving them more susceptible to the disease scourges so prevalent through those times. Leprosy, which to-day seems unable to make headway in middle temperate climates, swept up over the whole of Europe in the severe form seen to-day only in regions of tropical heat. It and other scourges declined with the oncoming cold of the Renaissance period, and European populations began a growth spurt which has since filled all the far corners of the globe.

Since man has seemed to recede in body size and speed of development with long historical periods of warmth and to blossom forth in cooler centuries, it appears likely that people of to-day should be showing evidences of another beginning decline in physique as earth temperatures again approach the Dark Age level. The present long rise in temperature has been slow and halting except for the more severe upthrusts of the past two decades, but the high temperatures of the last ten years have carried us up close to the levels of Viking times, judging by the depth of summer thaws in the old Greenland cemeteries. If these temperature changes really are a factor in human development, then the present astonishing growth tide should by now be showing signs of a reversal.

Recent close check of college freshman stature indicates that such reversal is indeed already in progress. Many months of the most tedious and uninteresting kind of work were spent in collecting and sorting data from some sixty-odd thousand student health cards, but the point seemed of sufficient importance to justify such efforts. Stature changes in entering freshmen were studied at four state universities ranging in latitude from North Carolina to Wisconsin. State schools were chosen because their freshmen are mostly drawn from nearby areas and are more representative of the population of their immediate neighbourhood than would be the case with private or sectarian schools.

Briefly stated, I found that the height of freshman girls at the universities of North Carolina, Kentucky, and Kansas became stabilized about 10 years ago. The girls still seem to be getting slightly heavier with each entering class, but no further height increase is taking place. The height of boys stopped increasing about 8 years ago, but they are still gaining in weight. Farther north the Wisconsin freshmen still continue to gain in height and weight, although the height gains are now quite small with boys and girls of successive entering classes. Freshman boys in Wisconsin are on the average an inch taller and 5 pounds heavier than those of Kansas and Kentucky.

During the recent decades of marked stature improvement there had also been a change toward earlier onset of puberty. Sexual cycles of freshman girls now begin a full year earlier than they did 30 years ago. This trend toward ever earlier onset of puberty has recently changed again, however, for North Carolina freshman girls born since 1918 have shown a progressively later age for beginning of their sexual cycles. At Cincinnati and in Kansas the reversal came a year later, while in Wisconsin only the faintest hints of a turn have been found.

Even down in the high schools, body size is tending to become stabilized for given age groups. The 15-year-old children of this year's class do not show so much gain over those of last year's as was the case a decade ago. In fact, following the severe heat of the 1934 and 1936 summers in Cincinnati, the stature of high-school children received an actual set-back. Instead of showing the usual yearly improvement with successive classes of 12-year-olds, for instance, children of this age were actually smaller after those hot summers than had been the case in former years.

Down at the grade-school ages stature is still improving. Each year's crop of 9-year-olds is better developed than was that of the preceding year. But stabilization seems to be advancing through the years of youth toward ever earlier ages, so that we may expect before many years to see even the 5-year-olds of one year no better than those of the year before.

Improved methods of feeding and a better supply of fruits and green vegetables at all seasons have no doubt been responsible for much of the improvement in growth through childhood and youth. This was probably an important factor also in the advancing adult stature. But to-day we face an oncoming stabilization and probable recession at a time when dietary standards and the availability of proper foods are better than ever before. Furthermore, the growth tide reversal is taking place even in that part of the population usually best nourished. Some force other than mere food deficiency must therefore be at work over the earth, reversing our trend from racial expansion in size and vitality into the start of a profound retreat.

This finding of a beginning biologic recession gives sharp emphasis to the social and economic turmoil around us. Ponderous forces seem perhaps to be again turning man's course downward after centuries of most remarkable advance and achievement. If changes in world temperatures really affect us in the ways pictured in these pages, then we do indeed seem to be heading into a period of prolonged and disheartening decline.

Perhaps you feel that this gloomy view of the situation is not justified, that man's control over his physical environment is much better to-day than it was 2,000 years ago, and that science will find ways to prevent the calamity which seems to impend. Any such optimistic attitude seems hardly warranted, however, for already there has been a sharp shrinkage of funds available for scientific research and higher education. European countries suffered for years from this dwindling support while our funds were still plentiful, but the financial trend of the last ten years in America has cast dismay over those in charge of our institutions of learning and research. Increasing amounts of federal funds are being doled out from Washington in an effort to keep scientists at their investigations, but with such support often goes a degree of open or hidden dictation regarding the kind of work to be done; any such regimentation of science will almost certainly result in impaired productivity.

Great discoveries usually arise from among a large number of futile-appearing individual projects scattered here and there. At first glance the multiplicity and duplication of these scattered efforts make science seem very wasteful, but no better way has yet been found to give hidden genius its chance to emerge. A very considerable element of chance lies behind the making of important new discoveries, hence the broadest and least restricted working base will always give greatest results.

Science of to-day should make every possible effort to put its new findings into easily understood language, especially whenever they bear directly upon the public welfare. Many investigators have in the past scorned to recognize this duty; but with the present increasing dependence upon public funds, workers will be compelled to thus justify their projects in the public eye. In passing from the field of abstract science into concrete utilitarianism, fundamental developments may suffer; but it seems that the change is upon us and that its implications should be recognized by all. Here, as elsewhere, publicity can easily be overdone and workers greatly handicapped by too active salesmanship; but in general the reporting of scientific findings is to-day very well done and merits the closest cooperation from investigators.

In quite another direction there is also room for doubt as to our ability to benefit long from present scientific knowledge. To-day we see public and personal health measures producing widespread reduction in many diseases and bringing about a progressive lengthening of the life span. This has been offsetting quite largely the reduction in birth rate of recent decades. City water supplies have been purified with untold saving of life. Malaria has been eradicated from large areas. Cholera, typhus, and yellow fever are being restricted in their spread from regions endemically affected. But eternal vigilance is the price we must pay for these highly desirable results. And vigilance is costly in energy terms.

Tropical cities to-day maintain safe water and sewage systems only by an importation of energetic overseers from the more dynamic temperate regions. If left entirely in local hands, they would within a very few decades succumb to political graft and revert to their former indolent filth. Even with smallpox vaccination in the most enlightened regions, it is only constant compulsion which maintains a high degree of mass immunity. Were this compulsion removed, vaccination would soon drop to quite ineffective levels, and real epidemics of the disease would again appear. We have to-day a very good example of this in the sector of the United States lying west and north of Missouri. These 16 states provided almost nine-tenths of the country's 15,111 smallpox cases in 1938, although they contain only about a quarter of the total population. In 3 of them compulsory vaccination is actually prohibited by law!

Even our food supply is made safe only by a thin veneer of governmental control which is kept effective by constant vigilance. Sickness and death lurk behind the least carelessness in the preparation and handling of our milk supply, our canned foods and meats, the drugs we use, and the beverages we drink. And in the city air we breathe, only the faintest beginnings have yet been made in the eradication of harmful contaminations.

A few decades of falling energy level and initiative could, and probably would, bring about a rapid crumbling of this fragile defence shelter we have built up around our health and welfare. Not only would scientific advance cease; we might well rapidly slough off much of our present application of scientific discoveries. Even in the mechanical field, or perhaps most markedly there, regression would be disastrous. Mechanical developments of to-day have become so complicated and involved, depending on such high degree of accuracy and skill, that they would be quickly affected by a loss of initiative and intense mental application to the problems at hand. How long could air transportation survive an increasing carelessness, when one mechanical fault in construction or operation means certain death for many passengers?

Our vaunted advances thus render us all the more vulnerable to a recession in energy and initiative if it is to come. We need not delude ourselves into a false sense of security behind our present level of scientific development, for there is no such security. What use was made of the valuable knowledge amassed in early Greece and Rome when man descended into the murky centuries of the Middle Ages? Yet medical knowledge of the early Greeks compared well with that of to-day except in the phases dependent on mechanical skill and precision. In medicine of to-day, as in transportation, industry, and the arts, we place great reliance upon mechanical devices of highly technical character. Should the control of society's welfare be taken from the intelligent and ingenious few and be grasped by the hands of the ignorant many, our machine-age civilization would speedily crumble and plunge us into another Dark Age.

As man has gone down in past tidal recessions, he not only ceased actually adding to his knowledge but even lost his ability to use that which he already possessed. For instance, it has been recently pointed out that in early Egyptian and Babylonian times mathematical knowledge was far advanced, but that from about 2,000 to 500 B.C. no use whatever was made of such functions as quadratic equations. With the early Greeks such knowledge was revived and given much further progress. But it once more suffered a complete eclipse during the Middle Ages, as mankind receded in all other ways. Revival and marked mathematical advances have again held sway since the time of the Renaissance.

If such abstract and fundamental knowledge and mental skill as that required for higher mathematical works can suffer such complete eclipse with long periods of warmth and physical decline, then we should no longer doubt the precariousness of our present situation. Our complete dependence upon the machine, and upon the intricate technical knowledge required to keep it in operation, renders us very susceptible to the long mental decline which now seems perhaps due to recur. Ours will probably be looked back upon as the Mechanical Age of Science and Industry, abandoned by man as he lost the mental acuity to operate successfully the intricate devices previous intelligence had invented.

Still another feature of the tidal change which has been causing concern in high places of several nations is the increasing reduction in reproductivity. For almost 80 years the fertility of English women has been declining, and estimates have been made that another 150 years of similar decline may bring the population down to perhaps one-tenth of its present mass, with reversion to a pastoral type of life. The wave of nineteenth-century reproductivity doubled human numbers on earth but showed signs of slowing down by the end of the century; during the early decades of the twentieth century this loss of momentum became alarming in several of the previously most vigorous peoples. Interesting speculation may well arise as to just how far this reduced fertility may go toward bringing about an actual reduction in human numbers on earth during the centuries ahead.

Serious social consequences arise from the change in racial reproduction. Fewer children will soon mean less crowded school conditions in the cities of America. For many decades we have been frantically enlarging our school facilities, only to find the new quarters soon just as crowded as the old. That will soon cease and be replaced by a yearly decline in enrolment. Such a decline has already begun, for in many American cities primary-grade enrolment is 25–30 per cent. less than it was ten years ago. A pre-war study in London showed that the school population will be less than half what it is to-day if the birth rate continues for another 20 years its course of the past several decades. However, as the burden of educating fewer children lessens through the decades, society will be faced with the problem of caring for a growing proportion of aged dependants. So perhaps we shall soon be converting our fine school buildings into homes for the aged.

Man to-day faces a real challenge. He has the intelligence and skill to control artificially those very factors of his environment which produce wide fluctuations in racial capacity and development. This intelligence, however, resides only in a few members of the total human mass, and can function effectively only as the masses understand, encourage, and apply its dictates. Whether the genius and high intelligence of the few will be permitted to function therefore depends entirely upon mass psychology and the social and political motivating forces directing the course of events. If those forces favour individual opportunity and the exercise of initiative, then mental genius will be stimulated to the utmost. But with the mass demanding "subsistence" and "social security," less attention will be given to encouraging the inventive genius of the race.

Many people claim to see another dire threat to the usefulness of science in the labour revolution now taking place over the world. Rugged individualism of recent centuries had its faults and selfish aspects, but its keen appreciation of the value of scientific discoveries was largely responsible for the amazing developments of the machine age in which we now live. But may not labour develop a similar appreciation after it has had more experience with the responsibilities of national guidance? Here, as on the field of battle, Russia provides ground for optimism, for her scientific men are given every encouragement and occupy most favoured living conditions. A short 25 years of labour rule there seems to have accomplished great things, to have changed a lumbering, clumsy, discontented giant into the fervently patriotic people who to-day are matching most intricate skill in a war to the death against the world's best organizers and accomplished scientists. No matter how many doubts we may have had regarding the Russian political philosophy of recent decades, the whole world should now be willing and anxious to understand more about the workings of the forces which have wrought such changes.

There can be no gainsaying the fact that labour is definitely on the move toward a higher place in world affairs. The labour-union ferment had long been at work before the massive Russian experiment began. The matter came to a head in Britain with the general strike of 1926 and the formation of MacDonald's Labour Government. Even in far-off China, the Nationalist uprising which reached Peking as we were leaving in 1928 was largely on this basis; and the Chinese Red Army has given a most able account of itself in the years of defence against Japanese aggression. Its 6,000-mile trek around the Kuomintang forces to get at the Japs in the north will live for ever among the world legends of patriotic performances.

It is indeed unfortunate that the bitter struggle for power here in America should have come at a time when long-established trends of various kinds seemed to be charting a new course. It looks very much as though our President was right a few years ago when he said in effect that old landmarks no longer sufficed, that we were putting out upon uncharted seas with only experimental soundings taken from time to time to guide our course in the troubled years ahead. Events of 2,000 years ago, as ancient civilizations began slipping into the abyss of the Dark Ages, can help us little to-day, for scenes and people change with the passing millenniums. The real tragedy of America—and other countries—of to-day is that ponderous trends so often go on unrecognized, with a nation's wealth and accumulated advantages being dissipated in bitter class opposition. If only the certainty of the change and direction of trend were more obvious and convincing, much human misery and wasting of values might be avoided.

If another recurring millennium of warmth is now really plunging humanity back into a new Dark Age, we may well consider the possible rearrangements in world power which may take place. The present global conflict is erasing national boundaries and bringing about new international alignments which may have a profound influence upon the future course of history. All now is fluidity, with every thinking person realizing that there can be no return to pre-war conditions. A new scheme of things must be constructed after the war has ended. Who will sit at the head of the peace table and whose will be the dominant voice?

Many people have professed to see a "rising tide of colour" as the conquering grip of Western nations has shown signs of relaxing its hold over the population masses of tropics and Orient. The present onrush of Japanese conquest provides sharp emphasis to the changed relations now clearly seen for the first time. Japan has availed herself fully of the Western world's mechanical ingenuity to weld a powerful military machine. Her men are no fighting prodigies, however, as has been demonstrated whenever they have come to grips with American forces under conditions of equal equipment. In fact, the ragged troops of China, with almost no military background and entirely negligible equipment, are often out-fighting the Japanese invaders.

The really crucial factor responsible for Japanese conquests in the Far East would seem to be a softening and crumbling of the hold Western nations have long exercised there. The French Empire is gone; that of Britain is rapidly following. The day of a dominant white-race is past so far as the Orient and all Asia are concerned, and the same may perhaps well hold for the human masses throughout the tropics.

If and when Germany and Japan can be defeated and demilitarized, it would seem logical that dominant places at the peace table should be occupied by Russia and China. These are the two peoples who have done the major part of the heavy fighting, who have provided the most steadfast and grim resistance to the aggressor nations, who ask nothing in return except the privilege of pursuing their home affairs without outside dictation. Endowed with a high degree of realism in world affairs, they should have a large part in the post-war reconstruction of the Eurasian situation. They are the ones who must continue to live alongside the present trouble-makers. People of America are farther removed from the seat of trouble and have a somewhat more academic interest in the whole matter. So let Stalin take the head seat, with Chiang Kai-shek on his right and the Anglo-Saxon group on his left.

As for a "rising tide of colour" engulfing the white race, the chances for such are probably negligible so far as the Negro race is concerned. Even though a diminution of climatic stimulation should leave present temperate-zone nations at a lower energy level, they would still be living on a higher plane than would the tropical races. Negroes who migrate northward here in America rapidly lose their high reproductivity, their birth rate even falling below that of similar economic groups among white residents.

The outlook is quite different, however, with respect to the Mongoloid peoples. As the Western nations are subdued by rising world temperatures and loss of cyclonic storminess, their energy level will sink down nearer that of Japan and China. The Oriental position will thus enjoy a relative improvement. With the present rejuvenation China is enjoying from having been pushed back into her more invigorating hinterland, she may very well come forth as one of the world's great powers in coming decades. Japan had her chance, but became too impatient of restraint and flew off into an orgy of conquest by force. Let us hope and pray that realism, properly tinged with altruism, will rule the course to be followed by the Big Three groups at the peace table and in the decades to follow.

CHAPTER 23

EPILOGUE

A PERSON SHOULD FREE HIMSELF occasionally from the humdrum details of daily life, focus his attention upon these larger influences affecting his existence, and develop a better appreciation of his own small place in the universe. The day's petty irritations and disappointments melt away into insignificance as he merges his being into this celestial harmony of mighty forces. The sun, moon, and beautiful planets travelling along that much-used sky pathway all have their part in human affairs. When viewed against the background of this outside control, the doings of one's neighbours or attempts to amass earthly wealth lose much of their seeming importance. Great consolation comes with the knowledge that other forces than man's own puny efforts are at work determining his fate.

My moments of keenest satisfaction and most complete mental peace have been those when the grandeur of nature's artistry has cast its spell over me. Such was the case as I stood on the Peking Wall—high above the teeming masses of China—to view the gorgeous sunset colouring over the Western Hills; also as I gazed across Lake Geneva from the pension balcony to watch Mount Blanc catch the final rays of the setting sun; and as I sought a secluded spot on the ship's deck in mid-Pacific with almost the regularity of a sun worshipper to enjoy the glories of sunrise and sunset across placid tropical waters. Even as a child I wondered what influences were behind the grandeur and beauty so often displayed in sky colouring. Now, as an adult with some knowledge of what it all means, I can sense in these physical forces the near presence of the real Ruler of Creation.

Humble acknowledgment of one's dependence upon these directing cosmic influences can well replace much of the egocentric bigotry recent generations of people have developed. In certain favoured climates of the earth man has indeed performed great feats, especially through the stimulating cold of the past few centuries; but with all his remarkable advances, he should keep before him a clear realization of the environmental factors which have made his achievements possible—and which may some day change him into a somewhat less superior being. Humility is said to be good for the soul, and here lies abundant cause for human humbleness. The energetic man of stimulating regions should appreciate the good fortune which placed him under such favourable circumstances. He has no cause for egotism; instead he should give credit to the natural forces which made possible his accomplishments, remembering that *climate makes the man.*